COLLABORATIVE PROFESSIONAL DEVELOPMENT AND CURRICULUM ENACTMENT: TEACHER REFLECTION TO INFORM INQUIRY-BASED DISCUSSIONS IN HIGH SCHOOL SCIENCE CLASSROOMS

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DEDICATION

To my loving family: Grace Akama, Nta Asuquo, Kaine Alozie, Chitua Alozie, and Effiong Dampha, for loving me, always.

To David Grueber, for your love and support through it all.

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ABSTRACT

Professional development for practicing science teachers has been a goal in education for the last two decades. Studies have shown that the quality of teacher instruction may be linked to teacher participation and involvement in professional development programs (Fishman, Marx, Best, & Tal, 2003). Furthermore, reflection during professional development has been emphasized as an important aspect of teacher learning (Birman, Desimone, Porter, & Garet, 2000; Dinkleman, 2003). However, we have yet to fully understand how teacher reflection and the components of professional development can be linked to changes in classroom instruction (Fendler, 2003). This study incorporated a variety of resources, including AAAS criteria, research-based discussion strategies, educative curriculum materials, a common curriculum, and in particular, a committed researcher, video artifacts and science education research articles, to provide teachers with opportunities to engage in an iterative process of reflection and instruction to bring about instructional change; a process of self-examination and experimentation that was fostered in a small group, collaborative, and sustained professional development program. I also

show that the role of the researcher is a key element in connecting professional development and classroom instruction. This study used interviews, professional development workshops, and teacher enactment to show that the design of professional development can foster a teacher learning community of reflective practice that promotes instructional change in inquiry-based science when resources are used to support and complement each other.

CHAPTER 1

INTRODUCTION

Professional development for practicing science teachers has been a goal in education for the last two decades. Studies have shown that teacher instruction may be linked to teacher participation and involvement in professional development programs (Fishman, et al., 2003). However, we have yet to fully understand the characteristics of professional development that may link teacher reflection to classroom instruction. In addition, with the pressures of statewide and national standards, schools and teachers may not have the time and money to invest in the kinds of professional development workshops that can potentially lead to improved instruction (Goertz, 2001). As teachers struggle to meet the demands of teaching large amounts of science content in a school year and complex scientific skills, the need for intense, sustained and focused professional development grows. Although school districts implement a variety of professional development programs, they have generally been criticized as “woefully inadequate” (Borko, 2004).

Research in education has begun to characterize the conditions for improving teaching and learning through professional development. I aim to

contribute to the exploration of effective professional development characteristics by engaging practicing science teachers in a series of professional development workshops that utilize a variety of the structural and conceptual components of professional development that have been shown to be effective, such as video observation of their own instruction, repeated meetings over an extended period of time, and reflection on teaching. More specifically, the goal of this dissertation is to investigate how professional development can help teachers change instruction to engage students in rich, inquiry-based discussions in high school science classrooms.

Educational Reform and Effective Professional Development

In this era of educational reform, teachers must be prepared to engage students in complex activities that require student participation in various disciplines. Changing existing and traditionally fundamental aspects of teaching, such as how knowledge is represented in the classroom, classroom discussion patterns, cultural norms, and the roles of teachers and students within that culture, is complex and difficult. As teachers begin to move towards the enactment of activities, skills and social habits that reflect complex scientific practices, such as inquiry, teacher pedagogical content knowledge must develop in the same direction. Research has questioned the issue of whether a change in teacher instruction can be linked to a single professional development seminar. Research is still unclear about whether structural changes at the school level, the professional development of teachers, and classroom teaching practices continue to have weak links due to the lack of sustained professional development.

In order to change the way science is taught in the classroom, teachers, administrators, principles, students and parents must have the opportunity to learn new concepts, new ways of presenting content, new ways of interacting with students, new forms of professional development collaboration, and alternative procedures for sharing instructional problems (Vandenberghe, 2002). Establishing professional development workshops that promote a change in teacher practice is an area rich with opportunities for understanding what counts as effective professional development.

Effective professional development is argued to transform teachers' practices to reflect high standards of reform-based education (Birman, et al., 2000). There is widespread agreement among educators that the advancement of skills of comprehension, composition, active processing and experimentation are not developed by passive reception of facts, but by active processing of information. This constructivist view (Piaget, 1983; Vygotsky, 1978) of learning, with its call for teaching particular skills within authentic contexts, for modeling expert thought processes, and for collaboration and external supports to help learners achieve intellectual accomplishments they could not achieve on their own, provides some of the underpinnings for education reform. Scholars in education argue that learning should not happen through decontextualized and disconnected tasks, but through tasks that are personally challenging and meaningful to them (Lave & Wenger, 1991).

Reform in science education promotes inquiry-based instruction, where students attempt to convert information and data into useful knowledge; inquiry-

based instruction is an extremely complex practice that is unlikely to be fostered without sustained professional development activity. In inquiry-based learning, students solve problems by connecting the classroom tasks to prior knowledge. They learn to ask questions and design investigations to answer their questions. As students share their ideas through discussions, they revise their ideas based on collected data. Thus, in order to prepare teachers for the challenges of enacting of inquiry-based instruction, professional development must also change (Darling-Hammond & McLaughlin, 1995).

In summary, reform in science education requires instruction that helps students develop complex skills. In order for teachers to make changes to their practice that reflects the demands of reformation in science education, changes in professional development that gives teachers opportunities to form study groups, reflect on practice, use multimedia resources, incorporate current research in the enactment of inquiry practices, and experiment with teaching strategies for in-the-moment teaching. At this time, science educators are looking for structural and conceptual foundations that lead to effective professional development (Darling-Hammond & McLaughlin, 1995)

Professional Development to Improve Classroom Instruction

As part of professional development, teachers reflect on their practice as they assess and critique each other's instruction. Colton and Sparks-Langer (1993) present a framework that describes teachers as reflective decision-makers, where teachers are thoughtful, intrinsically motivated to analyze situations, set goals, plan and monitor actions, evaluate results and reflect on their own personal teaching. Through reflection, teachers can identify problems

that they are facing, search for and suggest solutions, form a hypothesis about what can be done to solve the problems they are facing, use experiences to consider, compare, and evaluate suggested solutions, and test their hypotheses against the realization of the desired ends (Dinkleman, 2003; Schon, 1983; Wade, Fauske, & Thompson, 2008).

To address the need for change in professional development that promotes systematic teacher reflection, this study used principles of effective professional development to explore how professional development can help teachers be reflective on their practice, thereby helping them teach inquiry practices that are complex and therefore difficult to enact. In this study, professional development sessions focused on supporting high school biology teachers with inquiry-based discussion practices. Although an essential feature of inquiry-based instruction includes rich discussions, they can be problematic as students struggle to navigate through several types of classroom and scientific discourses (Moje, Collazo, Carillo, & Marx, 2001). Since traditional approaches to professional development have been criticized, new approaches that help teachers meet current standards of learning and instruction (National Research Council (NRC), 2000), such as the use of discussion in inquiry-based instruction and learning, need development and implementation.

Given that inquiry-based instruction is difficult for teachers to learn and incorporate in their teaching, and that professional development that is sustained over time, content based, and reflection oriented is a desired structure and method of teacher learning, I have designed a study that investigates how these

components of professional development can and potentially inform practice. Broadly, my research focused on ways sustained, collaborative and curriculum-focused professional development workshops could help teachers engage students in scientific discussions in the classroom. More specifically, my research goal was to answer the following questions: 1) What kinds of reflection opportunities are afforded by sustained and collaborative professional development workshops? 2) How can teachers' enactment of inquiry-based discussions demonstrate their reflection practices, as shown in the collaborative professional development workshops?

I have developed a study to show that teachers can enhance their knowledge and skills and change their classroom teaching of rich and open-ended discussions as they reflect on their practice through participation in professional development that is sustained, collaborative and curriculum-based. The professional development used several resources to provide opportunities for reflection-on-practice, such as a set of standards-based criteria, studying video of teacher enactment to reflect on and discuss instruction, examining and adapting discussion teaching strategies, developing embedded curricular supports, and reading current research studies. These activities served as the core of a sustained professional development for inquiry science teaching.

A previous study (Alozie, Moje, & Krajcik, 2009) showed that the predominant instructional and interactional discussion patterns in high school classrooms were consistent with IRE recitation. IRE recitation refers to a discussion that is initiated (I) with a question by the teacher, usually a recall

question, which is followed by a student response (R), usually consisting of one word. The teacher then evaluates (E) the response with positive or negative feedback. Although we speculated on why IRE remained dominant in the science classroom and how to support teachers in moving away from this discussion pattern, we still had questions on what professional development would look like to achieve this goal. We did not explore the reasons behind teacher decisions, the problems they faced, how they solved those problems, and how they evaluated and revised those problems. This study can help research in education begin to understand teacher reflective processes, how different resources provide opportunities for reflection, and how reflection can contribute to their teaching practices.

To address the research questions and the issues found in the Alozie et al. study (2009), I worked closely with 3 high school teachers enacting a genetics and genomics curriculum and 1 administrator. We met every 2-3 weeks in professional development workshops that used various resources (criteria, video artifacts, strategies, curriculum materials and education research articles) to help us think about how to promote inquiry-based discussions in the high school science classroom. During professional development, we watched video of enactment, reviewed research articles and set classroom enactment goals. The professional development workshops provided me the opportunity to analyze the process of reflection as the teachers participated in professional development, and how their enactment demonstrated their reflection process. Through my analysis, I showed that professional development can give teachers opportunities

to reflection on their practice. Furthermore, I showed that teacher reflection during professional development can demonstrate instructional changes, and reveal tensions that teachers encounter during instruction. Finally, this study suggests that professional development can give teachers opportunities to be reflective and to set instructional goals for themselves. However, because teachers were met with several constraints and uncertainties as they attempted to align their instruction with professional development, the link between professional development and instruction can be characterized as a continuum of change. The changes in instruction that teachers make can inform how professional development is tailored and designed for teachers.

Overview of Dissertation

Six chapters follow this Introduction. Chapter 2 presents a review of the literature on professional development and teacher learning. I discuss the theoretical perspective that conceptualizes learning as being situated, distributed, and social, and the role of reflection. I describe the call for a particular kind of professional development, and provide examples of effective professional development methods. Chapter 3 details the methods used to address the research questions dealing with resources used in professional development and their contribution to teacher reflection. I also explain how I used classroom observation to show links between enactment and reflection during professional development. Chapters 4, 5, and 6 all present results. In Chapter 4, I present findings on how resources helped unpack the process of reflection during professional development. In particular, reading and discussing research articles and observing and discussing teacher enactment videos played significant roles

in the evolution of teacher reflection. In chapter 5, I showed that, in particular, research articles created opportunities for teacher conversations to shift from a focus on teaching strategies to understanding student experiences and their effects on teacher instruction and student learning. Chapter 6 describes the consistency between teacher enactment and professional development reflection. I also show that although teachers set instructional goals for themselves, they were constrained in different ways. Finally, Chapter 7 shows a synthesis of the data to show that professional development can foster teacher reflection-on-action and can inform classroom instruction. I also argue that design-based research in professional development can contributed to the knowledge of effective professional development.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews extant and historical literature ranging from professional development for practicing teachers, teacher learning, teacher reflection, and inquiry-based discussions. In this literature review, I open by providing a theoretical perspective of teacher learning and how professional development can utilize what is found through research on learning. I review how teacher learning involves reflection and how teacher practice can be informed by teacher reflection. In this section, I describe the constituents of reflection, as described by Wade, Fauske and Thompson (2008) and Colton and Sparks-Langer (1993) and their relation to teacher learning and instructional modifications, and advocate for the inclusion of reflection as a regular practice in professional development. The chapter then discusses the need for professional development in American education. I review historical conceptions of professional development; with a focus on sustained and collaborative methods of professional development. Then, I describe the National Research Council standards for effective professional development in science to show the national request for professional development. Next, I show the need for professional

development to support teachesr as they attempt inquiry-based instruction. The chapter concludes with a review of professional development programs that have shown to be helpful in teacher learning and the improvement of teacher practice.

Through this review of the literature, I argue that reform in education calls for a change in professional development. Empirical evidence shows that effective professional learning continues over the long term and is best situated within a community that supports that learning (Darling-Hammond, 1997). Through this kind of learning, teachers can work on authentic problems within their professional practice (Lave & Wenger, 1991). Sustained professional development for practicing teachers is one forum in which teachers can participate in a learning environment that situates their learning with authentic tasks, while providing teachers opportunities to reflect on their practice. Through reflection, teachers can identify and solve problems that directly relate to their classroom instruction. The inclusion of reflection in professional development may not only encourage teachers to think critically about their practice, but can also promote changes in instruction.

Theoretical Framework: Professional Development and Teacher Learning

In this section, I provide a theoretical explanation for teacher supports that are beneficial for the improvement of science teaching. This study is grounded in the theoretical perspective that professional development can provide opportunities for teacher learning through learning environments that are social, situated in group settings, as well as in activities that are similar to what they experience in their daily practice, and distributed across different sources, such

as other people and technology. In essence, knowledge is constructed through interactions with other members of the group. Through a social learning environment, teachers can form discourse communities with one another. These discourse communities can provide cognitive tools, such as ideas, theories, and concepts, that the teachers can appropriate as their own and use to make sense of their personal experiences (Brown, Collins, & Duguid, 1989; Putnam & Borko, 2000).

Learning in professional development can be situated in a group setting, where teachers can discuss their classroom experiences while enacting particular skills in the classroom. Here, teachers would bring problems, issues and examples from their classrooms for discussion in professional development workshops to help them think about the enactment of specific instructional practices. "The learning of teachers is intertwined with their ongoing practice, making it likely that what they learn will indeed influence and support their teaching practice in meaningful ways" (Putnam & Borko, 2000, p. 6). Knowledge of particular practices can also be distributed among participants of professional development workshops. Each member of the workshop can contribute a different perspective and understanding of the content and/or skills being learned and discussed, thereby creating a rich body of knowledge that is shared among all participants. Finally, I will show that reflection can enhance teacher learning. As teachers reflect on their practice, they talk about issues and solutions to instructional issues and make decisions on how to change their teaching based on the reflection process.

Learning is Social

Professional development has the potential to help teachers meet standards for science teaching and create a teaching culture that values collaborative learning (Ellis, 1990). Releasing teachers from their isolation has been regarded not only as beneficial for teachers, but also, a necessary part of securing educational change in any enduring sense. Vygotsky was one of the first to advocate for social interactions as a way to develop cultural tools, like ideas and theories. He posited that the way a person thinks and reasons is largely shaped by their interactions with others (Vygotsky, 1978). Vygotsky (1978) argued that complex thinking and reasoning begin as interactions with others, then become internalized as individual forms of thought. As learners interact with other members of the learning community, new and different ideas are developed and formed.

Professional development can take the form of a discourse community, where groups of people share common interests (Michaels & O'Connor, 1990; Resnick, 1991). This discourse community can provide cognitive tools, such as ideas, theories, and concepts about teaching and learning, that teachers appropriate as their own through their personal efforts to make sense of their instructional experiences. Through talking with one another, individuals consider ideas that they may not have thought of before, potentially, incorporating them with existing ideas, or replacing former ideas (Vygotsky, 1978).

To move beyond traditional methods of professional development, teacher roles as learners will also shift from passive receptacles to active members and contributors of a discourse community. A number of educational reformers have

argued that opportunities to participate "in a professional community that discusses new teacher materials and strategies and that supports the risk taking and struggle entailed in transforming practice" (McLaughlin & Talbert, 1993) may help teachers construct new roles in the classroom. As teachers learn to engage in such discourse communities, they can also create discourse communities among their students. Furthermore, the notion of distributed cognition suggests that when diverse groups of teachers with different types of knowledge and expertise come together in a discourse community, community members can draw upon and incorporate each other's expertise to create rich conversations and new insights into teaching and learning.

Another important component of socially mediated learning is the process of coaching and mentoring (Fishman & Davis, 2006). Access to mentors and coaches can provide a social support for teachers, as well as facilitate the zone of proximal development. As teachers learn about new ideas and think about how to incorporate them into their practices, they can be coached or mentored by another teacher who has had experience with an idea or concept. A constraint with creating learning communities among teachers is locating where and how the learning is happening. As communities grow, they develop a shared knowledge, knowledge that both transcends and shapes the knowledge of individual participants. As researchers investigate teacher learning within these contexts, they struggle with how and when to capture group knowledge versus an individual's knowledge (Wilson & Berne, 1999).

An example of a project that developed a discourse community is the Community of Learners project (Grossman, Wineburg, & Woolwoth, 2001; Thomas, Wineburg, Grossman, Myhre, & Woolworth, 1998) where high-school teachers in a large urban school district taught English and history and met with university-based educators to read books, discuss teaching and learning, and design a humanities curriculum. A fundamental part of this work was the idea that each participant brought unique and special knowledge to the professional learning community. This study showed that within the high school teaching community, collegiality, as well as intellectual communities among the faculty within and across departments were enhanced. Furthermore, the university-based educators gained new insights about the time, effort, and trust required to reform the professional culture of teaching (Thomas, et al., 1998).

In addition, the formation of discourse communities changes the ways in which teachers talk about their practice. Participation in collaborative professional development workshops not only establishes a common body of knowledge, but it also establishes a common language and way of speaking about teaching. In their analysis of group interactions in a professional development teaching community, The Investigating Mathematics Teaching group (IMT), Pfeiffer and Featherstone (1996) found that the way teachers talked about their practice changed over time. First, the conversations became more sustained and focused. Second, the teachers showed passion in their conversations about the problems of practice. Third, teachers openly talked about their struggles, beliefs and failures; although this type of talk took sustained meetings and the

development of trust. Finally, as teachers became more comfortable with each other, there was an emergence of public disagreement. Pfeiffer and Featherstone argued that as teachers encourage students to be comfortable with disagreement, uncertainty, and conflict in inquiry-based learning, teachers must also learn to communicate in ways that may bring disagreement among participating members.

Although the formation of high school teacher communities is not a normal practice, discourse communities can be formed in high schools when teachers meet with university-based researchers to discuss and learn about ways to engage students in scientific discussions (Grossman, et al., 2001). University participants can bring teacher learning-communities the critical and reflective stance and modes of discourse that are important norms within the academic community. In addition, they bring research-based knowledge, such as conceptual understandings and clarifications (Shulman, 1986b), that can contribute to the improvement of teaching. Teachers, in turn, can bring their expertise about pedagogical practices, their students, and the cultural and instructional contexts of their classrooms to discourse communities. Together, teachers and university-based researchers can learn new ways of thinking about their practices and together create new forms of discourse about teaching by mutually contributing to discourse communities focused on improving science teaching.

Situated Learning

Teachers' classroom experiences can inform how they think and talk about their work. The situative perspective focuses on interactive systems that

include individuals as participants, interacting with materials and with each other (Greeno & Middle School Mathematics Through Applications Project Group, 1998).

The physical and social contexts in which an activity takes place are integral parts of learning that takes place within it (Brown, Collings and Duguid, 1989). The situative perspective argues that much of what we do and think is intertwined within the contexts in which we act. Because teachers spend a significant time in the classroom, their thinking is shaped and constrained by their classroom experiences. Many times, teachers have become fixed into a particular way of thinking and practice, and change becomes difficult. For example, it may be important to have teachers experience learning in group settings, where each member of the group contributes a body of knowledge that will cumulatively be used as tools to help them solve instructional problems. This means that teachers have to leave behind isolated views of instructional learning and think collectively within a group. Engaging teachers in learning experiences in different settings that can broaden their perspectives of teaching and introduce them to other ways of thinking may be necessary to release teachers from what may seem like inflexibility in instruction.

Although education stresses actively building on students' prior knowledge and experiences, it is not always stressed in teacher learning environments. Putnam and Borko (2000) argued that teachers should participate in authentic activities that they would experience in the field, if they expect students to have authentic activities that are similar to what practitioners do. When authentic

activities are transferred to a particular learning environment, like a professional development workshop, their context is inevitably changed; they become tasks that are required by professional development facilitators. Procedural routines, as a result, are then applied to what have become instructional tasks.

> The system of learning and using (and, of course, testing) thereafter remains hermetically sealed within the self-confirming culture of the school. Consequently, contrary to the aim of schooling, success within this culture often has little bearing on performance elsewhere (Brown, et al., 1989).

As a result, several research studies have investigated ways to situate teacher learning in their personal experiences, and take into account their prior knowledge. For example, Wilson and Berne (1999) have called on researchers to study professional development rooted in teachers' own practice. In their recount of professional development opportunities for teachers, they explain that there are three knowledge categories for teacher learning: (a) opportunities to talk abut subject matter, (b) opportunities to talk about student learning and (c) opportunities to talk about teaching. When reviewing talk about student learning, Wilson and Berne (1999) discussed how teachers changed their ideas about how students learn; moving to higher levels of theoretical understandings. They also showed that teachers talked of the need for community. In every case of sustained teacher learning, teachers were engaged in learning communities that allowed them to test, discuss, revise, and retry their ideas about children's thinking and its relationship to instruction. Additionally, as teachers participated in the professional development workshops, they used their experience as

learners to have a better understanding of how their students felt as learners solving math problems.

Situating teacher learning within personal practice also has the potential to influence professional discourse about teaching and learning, to engage teachers in a cycle of experimentation and reflection, and to shift teachers' focus from one of general pedagogy to one that is particularly connected to their own students. Sherin and van Es (2009) argued that using video provided teachers with opportunities to examine teaching and learning in new ways and have the potential to foster the learning called for by reform. An important and explicit goal of the study was to use the video excerpts to question, reflect on, and learn about teaching.

> Changes occurred both in terms of what the teachers chose to discuss in the video clubs, and in terms of how these topics were addressed. Specifically, over time, discourse in the video clubs shifted from a primary focus on the teachers to increased attention to students' actions and ideas. In addition, discussions of student thinking moved from simple restatements of students' ideas to detailed analyses of student thinking. Furthermore, teachers began to reframe their discussions of pedagogical issues in terms of student thinking (Sherin & van Es, 2009).

Distributed Knowledge

Putnam and Borko (2000) argued that cognition is not only a property of the individual, but distributed or spread across the individual, other persons, and various artifacts such as physical and symbolic tools. For example, cognitive activities can be socially shared among the participants of the professional development. Teachers can bring understanding and experience from the classroom because the may know how to contextualize issues and apply ideas directly to real situations. The teachers may also know the personal lives of their

students, such as the students' home-life, student attitudes, student experiences in other classrooms, and how those experiences will interplay with the teaching practices. The university-based researcher may bring knowledge of the literature, theoretical and conceptual ideas behind the teachers' experiences and learning, and a holistic view of the different components of learning and instruction.

By distributing the knowledge across participants, the understanding of one individual can change when another person in the group addresses information about an activity, concept, idea or skill. As the discussion continues to evolve over time, based on the contribution of each participant, the knowledge that is constructed also changes and develops. Information and knowledge transforms through mental, social, external and technological representational states (Rogers & Ellis, 1994). When individual contributions of knowledge and participant experiences are coordinated, new knowledge and understanding of science instruction can be established.

The Role of Reflection in Teacher Learning and Instruction

With reform in education underway, reflection in professional development has become a recurring concept of effective professional development and teacher learning. Colton and Sparks-Langer (1993) argued that teachers of the future are "thoughtful persons intrinsically motivated to analyze a situation, set goals, plan and monitor actions, evaluate results and reflect on their own professional thinking" (pg. 45). They said that technical proficiency is not enough; teachers need to consider the long-term social and ethical implications of the decisions made in the classroom.

There are several frameworks for teacher reflection. For example, Zeichner and Tabachnick (1991) stated that reflection was ill-defined. Claiming that a teacher's actions are justified just as long as he/she reflected about *something*, in *some* manner, is not sufficient. To categorize how teachers think about instruction, they put forth four perspectives of reflective teaching (see Table 1.1). In the first perspective, the academic perspective, teachers are considered to be the subject matter specialist. In this perspective, the teacher's job is to take subject matter and transform it into information that students can understand. Shulman (1986b) described this as pedagogical content knowledge. According to Shulman (1986), pedagogical content knowledge is when content knowledge embodies the aspects of the content that are most relevant and useful to its teachability. Pedagogical content knowledge also requires that the teacher take into account student prior knowledge and know how to address them.

The second perspective is the social efficiency tradition of reflective teaching. Here, the teacher looks to research for definitions of good teaching. Teachers can be reflective by using research on teaching as a standard for comparison. In this perspective, the teacher can try to conform to the standards of practice put forth by research, or be intelligent decision makers, where they exercise their judgment about the use of various teaching skills suggested by a variety of sources, including research. Here, the emphasis is on the teacher's ability to make decisions on the best use of generic teaching skills and strategies that have been suggested by research.

The third perspective is the developmentalist tradition of reflective teaching. In this tradition, the teacher studies the students' developmental process to inform their practice. Here, the teacher is not only the practitioner, but also the researcher, with the focus being on the students. The fourth and final perspective is the social reconstructionist tradition of reflective teaching. In this tradition, the teacher takes into account the social conditions of the school and issues of equity and justice when making instructional decisions. The teacher focuses inward on their own teaching, as well as outward, on the social conditions in which instruction is situated. Here, reflection takes into account the elimination of social conditions that can distort and upset the educative potential of schooling, issues of race, social class and access to school knowledge and achievement, and how creating a community of learners can help support and sustain the growth of teachers. Although each perspective has a different focus, they all intend to encourage critique of self and social/institutional conditions.

Colton and Sparks-Langer (1993) provided a framework to show how teachers can develop into reflective teachers. In their framework, they added several aspect of teacher learning that contribute to reflection development. They argued that a reflective teacher is motivated to grow; that they are interested in making a difference in the lives of their students, school, and community. In their framework, they integrated the cognitive, critical and personal characteristics to represent reflective decision making of teachers. They identified seven categories for the professional knowledge base in teacher reflection; content, students, pedagogy, context, prior experiences, personal views and values, and

scripts. Content refers to the teachers understanding and knowledge of the subject matter. Without understanding the content, the teacher may find it difficult to make decisions about what is being taught. Considering the students means that the teacher must be knowledgeable of the students' cultural backgrounds, development, and learning styles. This knowledge of the students will help the teacher make pedagogical decisions.

Pedagogy refers to generic methods and theories that are applicable to any subject. For example, the use of collaborative groups may be useful in both a science class and a social studies class. Pedagogy also refers to pedagogical content knowledge, where teachers make pedagogical decisions that are specific to the subject matter. For example, asking students to draw conclusions from data collected in an investigation may be more specific to a science classroom.

Colton and Spraks-Langer (1993) also argue that a teacher's understanding of the context, such as the time of day, the cultural backgrounds of the students, parents and community, and the politics of the school and district also play a role in the teachers decision-making process. For example, a teacher may feel constrained when promoting student argumentation in the classroom if the parents of the students do not agree with student and teacher argumentation, because the teacher is viewed as the authority figure. Such a constraint influences the decisions the teacher has to make when encouraging students to question science and the world around them. In addition to context, the teacher's prior experiences can also play a role in the decision making process. "Reflective teachers explore how the present situation links to their own prior experiences-

what they know about and have experienced with the students, the content being taught, the methods being employed, and the present context- before taking the best course of action," (Colton & Sparks-Langer, 1993).

The last two categories are personal and social values, and scripts. Personal and social values are formed by the teacher's family, personal encounters, readings, and life experiences. Scripts refers to the automatic and metacognitive behavior of the teacher when dealing with classroom situations. Colton and Spark-Langer (1993) show that a teacher's emotional response to a classroom situation will affect the way the teacher responds to the situation. They also explain that teachers define situations in the classroom by collecting information about experiences from several resources, like the curriculum and school policies. As teachers analyze information gathered, they may turn to outside sources for help, if their knowledge base is exhausted. External sources may be professional readings, which contribute to their reflective process by providing them with new and alternative solutions.

Colton and Sparks-Langer (1993) point to several phases of helping a teacher develop into a reflective teacher. Cognitive apprenticeship with a knowledgeable other will help the teacher develop mental representations and automatic scripts (behavioral and metacognitive) to interpret information, set goals, assess their actions and think independently. Interpersonal skills will help build rapport and trust. The ability to problem solve collaboratively provides opportunities for teachers to work together to frame, define, and analyze classroom problems by taking into account other perspectives. This is an

important aspect of reflection. Finally, coaching and supervision encourages the teacher to explore and be aware of their thinking and thought processes.

In 2008, Wade, Fauske and Thompson did a study on secondary teachers and their development of critically reflective problem-solving. “Critically reflective thinking is thought to benefit the teachers and students by widening teachers’ understanding of teaching beyond the narrow technical concerns to broader sociopolitical influences that affect students’ learning,” (Wade, et al., 2008). It can help teachers move away from viewing students’ culture and language as deficits or disadvantages that need to be fixed, so that they can provide a challenging and culturally responsive curriculum. Wade, Fauske, and Thompson (2008) used an online discussion group to understand the reflection process of the participating teachers. They based their framework of reflection on Schon’s concept of reflection-on-action (Schon, 1983, 1987). According to Schon (1983), a reflective practitioner thinks through a problem, and examines their own assumptions beliefs, and understandings by framing a problem from multiple perspectives, seeking solutions, and evaluating the proposed solutions. To be a critically reflective practitioner, a teacher thinks about how their actions affect their students’ personal identity and sense of self, how their actions affect their students’ intellectual development, and what kinds of social and political consequences their actions have.

To categorize and delineate how teachers think about student learning and their instructional approaches, Wade, Fauske and Thompson based their study on five reflection perspectives (see Table 2-1). Business-as-usual frames

problems as deficiencies that the students bring to the classroom and the solution as needing to repair the inadequacies of the students. For example, a solution might be tracking students into vocational programs; placing the responsibility on the student, family and their community. Remediating cultural deficiencies is an approach that believes that the "American society is good, just, and normal; failure to succeed is attributed to presumed deficiencies in children, their home environments, and/or their culture and language," (Wade, et al., 2008). The difference between this perspective and business-as-usual is that the teacher believes that they have some responsibility in repairing the students' inadequacies; helping them assimilate into the "normal" American society.

Sources	Reflective Perspective				
Zeichner and Tabachnick (1991)	*Academic*: Teachers are the subject matter specialist. Teacher pedagogical content knowledge is efficient.	*Social Efficiency*: Teacher looks to research for good teaching; research-based strategies.	*Developmentalist*: Teacher focuses on student developmental process.	Social Reconstructionist: Considers social conditions that affect students.	
Wade, Fauske and Thompson (2009)	*Business-As-Usual:* Problem is associated with student inabilities and student responsible	*Remediating Cultural Deficiencies*: Problem lies in student inabilities and teacher takes responsibility to remediate them.	*Teaching the Culturally Different:* Teacher learns about student backgrounds and culture. Adjusts curriculum to students and promotes monoculturalism.	*Human Relations*: Teacher learns about student backgrounds and culture. Adjusts curriculum to promote multiculturalism within the existing culture.	*Transformative*: Teacher promotes social change; to create equality for minority students.

Table 2-1: Summary of Reflective Perspectives

Teaching the culturally different is another perspective described by Wade et al. (2008). Teachers operating in this tradition want to learn about the backgrounds and strengths of their students, and use that knowledge to more affectively teach the curriculum. Here, the teacher alters the curriculum to fit the

backgrounds of the students, so that the students learn the content most effectively. The human relations perspective is similar to that of teaching the culturally different. The main difference is that the teacher alters instruction to value mulitcultualism, rather than prioritizing monocultural values. “Its goals are to reduce stereotyping and to foster tolerance, unity, and positive feelings toward other groups and cultures within the existing social structure,” (Wade, et al., 2008). Finally, the transformative approach seeks to promote social change that would create equality for minority groups and explain reasons for inequality. Here, changes in the curriculum are more important than altering strategy usage. However useful this might be socially, it is the least taught in schools.

Figure 2-1: Merged Concepts of Reflection

Figure 2-1 merges ideas from Colton and Sparks-Langer (1993), and Wade, Fauske, and Thompson to create a conceptual representation of how teachers can use opportunities for reflection. The outermost part of the circle represents the components of learning. Colton and Sparks-Langer (1993) explain that a teacher who is being developed into a reflective teacher goes through four phases; as shown in the first layer- cognitive apprenticeship, collaborative problem solving, coaching, and professional knowledge. When teachers go through the phases, they develop four attributes of a reflective teacher (shown in the second layer). First, flexibility refers to the teachers' willingness to understand multiple perspectives on an issue. For example, a group setting may provide opportunities for various ideas to be presented and discussed.

Second, efficacy refers to the teachers' willingness to have an impact on the students' lives and schools. For instance, the learning environment can promote the building and understanding of the teachers' professional knowledge. One aspect of professional knowledge is knowing the context of the school setting, such as student backgrounds. Third, consciousness refers to the teachers' ability to explain their reasoning to another teacher. As the teachers interact within the learning environment, look to each other for guidance, support each other, and work together to discuss instructional issues, they can talk through and explain how and why they make instructional decisions and changes over time.

Finally, social responsibility refers to the teachers' willingness to develop socially and politically responsible students; teachers are involved in their school,

district, local and global communities. For example, engaging students in discussions about ethical issues can help increase student awareness of social issues in science and help them develop skills in talking about such issues.

The center of the circle represents the process of reflection, as described by Wade, Fauske, and Thompson (2008). The learning environment and reflective teacher attributes can afford teachers with opportunities to ask questions about their practice, suggest solutions, and test and evaluate solutions though enactment.

The Need for Professional Development

Historical Conceptions of Professional Development

A common concern with professional development is the long and complex path attempting to strengthen weak links between the school institution, the professional development of teachers, and classroom teaching practices (Imants, Sleegers, & Witziers, 2002). In the classic conception of professional development, the school or school district brings in an outside consultant, curriculum expert, or subject matter specialist on a staff-development day to give teachers a one-time training seminar on a variety pedagogic or subject matter topics (Little, 1993). One could argue that this type of professional development is consistent with the process-product perspective. A study by Medeley (1977) argued that teacher education should be studied based on how the teacher performs in the classroom by conducting process-product research. Process-product searches for causal evidence, such as teaching effects on student learning, and analyzes instructional procedures that are most likely to prove useful in achieving certain instructional ends. Process-product research theorizes

student and teacher behavior as fairly stable, as generalizable across classrooms, and as objectively observable. He stated his viewpoint:

> The ultimate base of teacher education curriculum must be a thorough understanding of the dynamics of effective teaching of what a teacher must know, and be, and do, in order to provide the greatest possible assistance to pupils in their efforts to achieve the goals of education. Such understanding depends on the establishment of cause-and-effect relationships between teacher behavior and pupil learning. Only when we know why a teacher is effective—as well as how—can we decide how best to train teachers.

In this statement, Medley (1977) argued that a change in teacher behavior during instruction is directly related to student achievement and that in order for students to do well, teacher behaviors need to be "trained." In terms of how a teacher learns, the process-product perspective assumes that an effective teacher adopts behaviors that are linked to successful student learning outcomes. This perspective does not emphasize cognitive or social aspects of learning. Should a teacher attend a professional development seminar that is lecture-based, one may assume that the teacher is expected to learn by acquiring the suggested or demonstrated strategies and perform them "effectively" in the classroom. This type of professional development may consist of episodic updates of information transferred to teachers through didactic instruction and disconnected from authentic engagement and work experiences (Gravani, 2007). Essentially, teachers get one shot at learning something potentially complex and important for student learning and achievement. Shulman (1986a) explained that according to the process-product perspective, "effectiveness of teaching is seen as attributable to combinations of discrete and

observable teaching performances per se, operating relatively independently of time and place," (pg. 10). However, Little (1993) argued that traditional professional development is inadequate for the type of teacher learning that will lead to improved instruction.

Many of the research programs on teacher learning that came after process-product studies were stimulated by goals of correcting flaws in the process-product paradigm, or addressing situations ignored or invisible to its scholars (Shulman, 1986a). According to Schon (1987), in order for learning to occur, there cannot be a disconnect between theory and practice, as is often done in traditional forms of professional development. He stated that,

> If the model of technical rationality appeared only in such statements of intent, or in programmatic descriptions of professional knowledge, we might have some doubts about its dominance. But the model is also embedded in the institutional context of professional life. It is implicit in the institutionalized relations of research and practice, and in the normative curricula of professional education. Even when practitioners, educators, and researchers question the model of technical rationality, they are party to institutions that perpetuate it (pg. 26).

Schon (1987) explained that the technical-rational perspective creates a hierarchy, placing theoretical knowledge above practical expertise. According to Schon, the technical-rational perspective defines theory as "real knowledge" and application of said knowledge in the real-world as less relevant. He argued that technical-rationality in itself is insufficient. It assumes that there is one possible and correct outcome and does not consider complexity and uncertainty. He stated that the practitioner can either "stay on the high, hard ground where he can practice rigorously, as he understands rigor, but where he is constrained to

deal with problems of relatively little social importance," or he can work in the field, where "he can engage in the most important and challenging problems if he is willing to forsake technical rigor" (pg. 42). In the latter scenario, the practitioner learns from prior experiences to inform present actions. The practitioner knows how to accommodate surprises and unexpected occurrences. Little (1993) argued that the dominant model of professional development, which is focused on expanding individual repertoire of strategies, is inadequate for continued teacher learning. As teachers continue to make decisions, they are limited to a specialized set of strategies and ideas, often offered by a content specialist, and many times have difficulty with unexpected situations, as Schon (1987) described. Because, professional development is often structured as disconnected workshops that stress what Schon called "knowing that" rather than "knowing how," teachers continue to struggle.

Acknowledging that educating teachers was more than imparting knowledge moved researchers to examine the cognitive aspect of teacher learning. The cognitive perspective of learning asserts that action is not direct, like in process-product research, but instead is mediated by cognitive sense-making. The focus is on what the learner is thinking as they work on their tasks, rather than the performance of the task. For example, Anderson (1984) studied the way primary grade children coped with seatwork. In this study, she characterized student learning by analyzing thought processes and motivations surrounding the school work, rather than basing learning on student achievement and test scores. She looked at the differences in the kinds of strategies used by

high achievers and low achievers. Sfard (1998) argued that cognitive perspectives view knowledge as a product and the method for learning this knowledge is through acquisition. Contextual and social influences, including how one is taught, are either ignored, or are seen as means for enabling the acquisition of individual knowledge. In terms of professional development, teacher sense-making of instruction can be studied to understand and determine appropriate forms of professional development.

Situative perspectives argue that a focus only on cognitive structure is not sufficient to account for learning (Lave & Wenger, 1991). Instead, interaction with others and resources are both the process and the product of learning. In addition, this perspective argues that learning cannot be analyzed without analyzing interactional systems. Anderson, Greeno, Reder and Simon (2000) argued that the cognitive approach and situative approach together provide important insights into the process of effective performance and learning, and neither perspective is adequate on its own. According to Borko (2004), having an understanding of the relationships between various elements of professional development programs, such as the context, the teachers, the facilitators, and the program itself, can provide insight on how teachers' can learn and change their practices. Yet, this conception of professional learning has had little impact on professional development practices in education, with a noticeable disparity between research findings and practice (Borko, 2004).

In many cases, schools, districts and the federal government spend large amounts of money on various forms of professional development, yet, these

forms, are often fragmented, intellectually superficial, and do not take into account what we know about how teachers learn (Borko, 2004). According to Webster-Wright (2009), there are limitations behind the assumptions that drive professional development. First, she stated that professional development still considers the learning environment and the learner as separate. “Research is required that views the learner, context, and learning as inextricably interrelated rather than acknowledged as related, yet studied separately” (pg. 712). Research has shown that effective teacher learning continues over the long term and is best situated within a community that supports that learning (Darling-Hammond, 1997). Webster-Wright argued (2009) that professional development often limits opportunities for critical evaluation and reflection, and potential for change. She also argued that in order to gain insight to enhance support for professionals, in this case, teachers, there is a need to understand how teachers continue to learn through their working lives, rather than approaching teacher learning as performance-based, as in process-product studies. In addition, she argued that we must progress from a focus on how to best provide professional development activities towards understanding underlying questions on how teachers learn.

Embedding educative written supports in curriculum materials, designed to promote teacher learning is an alternative way to support teacher learning (Ball & Cohen, 1996). Educative curriculum materials cannot replace professional development opportunities but they can have a unique role. Curriculum materials, like textbooks, have traditionally been designed with student learning as the goal. However, materials can be designed to support learning by teachers as well.

Creating materials with teacher learning in mind is a new idea and is yet to be well developed or researched. Unlike the one-shot professional development workshops, teachers will be able to use curriculum materials over an extended period of time in the context of their classroom. Teachers are also accustomed to using such materials to plan and structure student activities (Ball & Cohen, 1996). It is argued that teachers' use of educative curriculum materials in the classroom can situate teachers' learning in everyday teaching experiences (Ball & Cohen, 1996; Brown, et al., 1989).

Ball and Cohen (1996) suggest curriculum materials can be educative for teachers by offering support for teachers in thinking about: (a) content beyond the level suggested for students, (b) underlying pedagogy, (c) developing content and community across time, (d) students, and (e) the broader community. Davis and Krajcik (2005) developed heuristics for the design of curriculum materials that encompass the mentioned characteristics. The heuristics provide context for how to promote teacher learning by serving as cognitive tools for teachers situated in practice. According to Davis and Krajcik (2005) teacher learning involves developing and integrating one's knowledge base about content, teaching, and learning, becoming able to apply that knowledge in real time to make instructional decisions, participating in the discourse of teaching, and becoming enculturated into a range of teacher practices (pg. 3). However, educative curriculum materials alone have their limitations. Teacher learning through educative curriculum materials is highly dependent on the quality of the educative features. Research is still determining what high-quality educative

curricula look like. In addition, if the educative features are too lengthy, then teachers will not have time to read them. Finally, the way teachers interpret the educative features of curricula will differ; potentially making the intention of the curriculum elusive.

A Call for Professional Development in Science

Over the past three decades, many gains have been made in understanding how people learn. As research continues to illuminate the process of learning, it continues to adjust how to help educate teachers, whether is it through professional development workshops or educative curriculum materials. With the need for a change in how teachers are supported through professional development, the National Research Council (1996) itemized standards for professional development for science teachers. The National Research Council (NRC) standards take into account extant literature on teacher learning, such as the situative perspective (Putnam & Borko, 2000), and applies it to teacher learning through professional development.

The NRC argues that professional development is a continuous process that extends throughout the teachers' careers and puts forth standards for professional development. Standard A states that professional development for science teachers should promote learning essential science content through the perspectives and methods of inquiry (pg. 59). Learning experiences for science teachers can involve teachers in actively investigating phenomena that can be studied scientifically, interpreting results, and making sense of findings consistent with currently accepted scientific understanding.

Aligning with inquiry methods of learning can enhance teachers' experiences in a professional development workshop. Teachers address issues, events, topics, and problems that are significant in science and of interest to the participants, while encouraging collaboration among teachers. In addition, this standard suggests that teachers be introduced to scientific literature, media, and technological resources that expand their science knowledge and their ability to access further knowledge. For instance, during professional development, teachers can read research articles and watch video of enactment, as a way to further their understanding of teaching. Finally, the standard suggests incorporating ongoing reflection on the process and outcomes of understanding through science inquiry.

Standard B states that professional development should integrate knowledge of science, learning, pedagogy, and students, and apply that knowledge to science teaching (pg. 62). One tenet of Standard B is that teachers should learn in appropriate contexts, where effective science teaching can be modeled and illustrated, allowing teachers opportunities to struggle with situations that are relevant to their practice. In addition, the standard states that reflection, inquiry, guided practice and modeling should be a part of professional development, as a way to build understanding and skill in science teaching.

Finally, Standard C suggests that professional development provide opportunities for lifelong learning. Such professional development workshops provide regular and frequent opportunities for individual and collegial examination and reflection on classroom practice. During the workshops, teachers can give

each other and receive feedback about their teaching practices as a way to understand instructional practice and their application in their classrooms. Finally, the workshops can give teachers opportunities to learn and use various tools and techniques for self and group reflection. For example, teachers can reflect on their teaching by locating an instructional problem, brainstorming solutions to the problem, and then evaluating the solutions through practice (Wade, et al., 2008).

In the three standards that I described above, the National Research Council provides structural and organizational suggestions for professional development. Taken together, the standards integrate theoretical and practical conceptions of effective professional development.

The Need for Professional Development to Improve Teacher Enactment of Inquiry-Based Discussions in the Science Classroom

The Complexities of Discussion in Inquiry

Changing teacher practices is one goal of professional development. One such practice is the enactment of inquiry-based scientific discussions in the classroom. Scientific learning environments that advocate for the use of inquiry-based skills also promote teaching scientific communication by engaging students in classroom discussions, and potentially creating a discourse community in the classroom.

Inquiry-based approaches are premised on rich discussions where students learn to find solutions to real problems by asking and refining questions, designing and conducting investigations, gathering and analyzing information and data, making interpretations, drawing conclusions, and reporting findings. Collaboration and conversation is also considered important. Collaboration

involves students building shared understandings of ideas and of the nature of the discipline as they engage in discourse with their classmates and adults outside the classroom (Krajcik, Blumenfeld, Marx, & Soloway, 2000; Krajcik, et al., 1998)

Although researchers have argued that opportunities for oral exchange of ideas is a necessary inquiry skill, some studies have shown that during instruction, students have difficulty figuring out how and when to use several types of classroom and scientific discourses (Moje, et al., 2001). In this complex school setting, teachers are presented an array of students with highly variable characteristics and unpredictable responses, and therefore must process large amounts of information quickly. If supported, teachers can help students become socialized into the culture and discursive practices of science as a discipline (Krajcik & Blumenfeld, 2006; Krajcik, et al., 1998; Singer, Marx, Krajcik, & Chambers, 2000). As students learn to participate in the discipline of science as professionals do, developing teacher knowledge of this participation can enhance inquiry-based instruction.

The Discourses of Science Learning Through Discussion

Many scholars of science and science education have argued that scientific knowledge does not automatically arise out of independent exploration of the physical world, but is an expression of a particular way of knowing the world that developed through the enculturation into particular practices of a community of scientists (Crawford, Kelly, & Brown, 2000; Kelly & Green, 1998; Lemke, 1990; Magnusson, Palincsar, & Templin, 2004). In an ideal inquiry-oriented science classroom, students learn the practices and discourse of

scientists, or their ways of knowing, doing, believing, acting, reading, and writing (Gee, 1996), even as they also learn to analyze those practices. Blumenfeld, Marx, Patrick, Krajcik, and Soloway (1997) claimed that by entering into the discourse of science, for example, students learn ways of knowing in the discipline, what counts as evidence, and how ideas are validated and communicated.

In inquiry-based science classrooms, the creation of discourse communities is argued to help students ask questions, write explanations, form conclusions, make sense of information, discuss data and present findings (Krajcik & Blumenfeld, 2006). The challenge, however, is to integrate scientific discourse into the learning experiences of students. Curriculum materials that promote discourse in science are not often explicit about how to enact rich, open-ended scientific discussions in science classrooms (Moje et al., 2001). Specifically, Moje et al. (2001) show that the enactment of inquiry-based science classroom materials draws on a variety of discourses, including the discourses of science, instruction, and of everyday life. Within the science classroom, several discourses compete with one another, and when teachers and students are not explicitly supported in navigating those discourses, the creation of a scientific discourse community in the classroom becomes challenging (Moje et al., 2001).

Traditional Discourse Practices in Science

In addition to the challenges of negotiating multiple discourse communities, classroom discussions can be difficult as teachers attempt to establish classroom norms that utilize discussions. Although discussions rely on a variety of interactional structures, classrooms—especially at the secondary

level—tend to be dominated by patterns of teacher initiation of ideas, followed by student response and teacher evaluation. This Intitiation-Response-Evaluation (IRE) practice (Mehan, 1979; Tharp & Gallimore, 1991) is also sometimes referred to as *recitation* (Alvermann, Dillon, & O'Brien, 1987) or *triadic dialogue* (Lemke, 1990). During recitation or discussions resembling triadic dialogue, a teacher asks a question, a student provides a one-word response, and the teacher evaluates the student. Lemke (1990) claimed that in triadic dialogue the teacher tends to control initiating exchanges, set the topic, and control the direction in which the topic develops. Within this structure, students have little control directing the discussion or contesting teacher prerogatives (Lemke, 1990).

In this style of classroom communication, information is transmitted from teacher to students and there is little opportunity for student contributions (Wells & Mejia-Arauz, 2006); the discussion pattern can thus be considered *monologic* or *authoritative* (Scott, Mortimer, & Aguiar, 2006). Although monologic communication has its purpose and value, it does not align with the discursive goals of communicating in science learning environments (Polman, 2004), nor does it support the conceptual goal of students constructing knowledge (Wells & Mejia-Arauz, 2006). Students learning science (and any other discipline) need opportunities to discuss in settings where speakers and listeners attempt to understand the perspectives of the other, thereby promoting student participation in inquiry, discourse, and reasoning.

Inquiry-based discussion can be described as dialogic interactions among students in a science classroom. In dialogic interactions, the teacher encourages students to put forward ideas and explore and debate different points of view. In addition, students' responses are often tentative suggestions based on open or genuine questions, spontaneous, and expressed in whole phrases or sentences (Chin, 2007). As students develop cultural skills of negotiation and questioning skills in science, they become active members of the scientific community while continuing to remain learners with agency, rather than passive learners (Polman, 2004). Jimenez-Aleixandre et al. (2000) found, for example, that when high school students were given opportunities to solve problems, discuss science, and talk science, they used a variety of communication operations, such as argumentative and epistemic, thereby developing additional non-conceptual skills of communication and discussion. Although students may respond to opportunities of problem solving, teacher instruction and interactions play a critical role in the discussion (Caravita & Hallden, 1994).

Developing these dialogic discussions in the science classroom is challenging, however, especially at the upper grade levels, because spontaneous engagement in scientific talk among students is rare (Lemke, 1990; Moje et al., 2001). Indeed, Vygotsky (1986) argued that one of the primary goals of learning is to move from spontaneous thinking to academic thinking and ways of speaking. For many secondary school students, however, schooled in monologic or authoritative discourse practices over time in classrooms, dialogic discussions about disciplinary ideas have been rare; as a result, they are not skilled in such

discussion practices, and neither are their teachers (Nassaji & Wells, 2000). In fact, Nassaji and Wells (2000) claimed that even with efforts of fostering dialogic discussions in science classrooms, triadic dialogue continues to be the dominant discussion structure. Due to the prevalence of triadic dialogue in science classrooms, teachers need substantial support in finding ways to integrate and manage competing discourses (Moje et al., 2001) and move classroom discussions towards dialogic interactions.

Instructional and Interactional Discourses: Practices of an Inquiry-Based Discussion

Supporting teachers in the enactment of inquiry-based discussion requires an understanding and knowledge of what a discussion consists of and how to bring those components of a discussion to life in the classroom. Research has shown that curriculum materials do not adequately support teachers in discussions (Alozie, Moje, and Krajcik, 2009) and suggest professional development as an additional and important method of support for teachers enacting inquiry-based discussions in the classroom.

One step to helping teachers become knowledgeable of the components of discussions is to make explicit what research has shown to be effective in the enactment of discussions. For example, to make discussions more dialogic and inquiry-based, Nassaji and Wells (2000) argued that altering the evaluative portion of the triadic dialogue to include non-judgment evaluations, such as follow-up questions, moves discussions towards dialogic conversations. In addition, Chin (2007) showed that using open-ended initiating questions rather than recall questions can also promote dialogic interactions. Chin argued that

open-ended initiation questions work well for dialogic discussion because they require students to confront and evaluate prior knowledge.

Furthermore, it is important that students know how to make their knowledge explicit during inquiry-based discussions. Within inquiry-based science discussions, students are required to weigh evidence presented by several of their classmates, looking for the most appropriate solution based on scientific reasoning and theory. Thus, it is important to carefully select one's tools of expression so that the significance of one's work is best signaled to the community (Magnusson et al., 2004). The use of evidence explained by scientific reasoning may act as a communication tool, help demonstrate student knowledge of science, and contribute to the dialogic nature of a discussion (Kuhn, Kenyon, & Reiser, 2006; McNeill, Lizotte, Krajcik, & Marx, 2006). Students should not only "get the right answer," but also learn to participate in a discussion involving several classmates with potentially different viewpoints and ideas, while using evidence and scientific reasoning to justify their thoughts and ideas.

Although providing teachers with enactment strategies may be one way to begin to establish discussion skills among students, developing classroom norms that welcome and value discussion is yet another challenge teachers face. In inquiry-based discussions, the development of classroom norms must be an ongoing process between the teacher and students. Teachers may help students develop collaboration skills, including turn taking, listening, and respecting others (Krajcik, Czerniak, & Berger, 2002). The teacher also manages the discussion by

avoiding a highly competitive environment and by helping students see that divergent results are a product of activity (Magnusson et al., 2004). Magnusson et al. (2004) also state that in order to enculturate students into a community of practice, teachers must establish and maintain the conversations norms of everyday discourse through proper etiquette, help students move back and forth between everyday and scientific languages, and give differential responses to students who appropriate scientific norms of communication.

Using Professional Development to Promote a Change in Instruction

Helping teachers learn about inquiry-based discussions may require more than traditional methods of professional development. As evidenced by the literature, inquiry-based discussions require changes in various classroom norms, interactions, roles, and ways of knowing. Scholars argue for additional research that shows how effective professional development promotes teacher learning and can be linked to a change in instruction (Birman, et al., 2000; Borko, 2004; Fishman, et al., 2003). According to Penuel, Fishman, Yamaguchi, & Gallagher (2007), effective professional development conditions and practices consist of reform-oriented activities, such as teacher study groups, more frequent professional development sessions, and the collective participation of teachers from the same school.

Professional development workshops can be interactive with teaching practices, and allow for multiple cycles of presentation and assimilation of, and reflection on knowledge (Ball & Cohen, 1996; Blumenfeld, Soloway, Marx, Guzdial, & Palincsar, 1991; Putnam & Borko, 2000). Such a process extends written embedded supports, like educative curriculum materials, by changing

them from fixed directions to guides teachers can adapt according to the culture and context of their classrooms. Professional development can help teachers make decisions on their instruction, make revisions to the curriculum, and create specialized supports for classroom-specific enactments.

Studies on Professional Development

Reform in teaching requires teachers to rethink their own practice, construct new classroom roles for themselves and their students, reconstruct expectations about student outcomes, and teach in ways they may have never taught before. In many cases, teachers have never experienced new ways of teaching themselves (Darling-Hammond & McLaughlin, 1995). Reform in professional development means providing teachers opportunities to reflect critically on their practice and build new knowledge and beliefs on content, pedagogy and learning (Darling-Hammond & McLaughlin, 1995).

Effective professional development is as important as student learning. The design of professional development speaks to the way reform in education takes place. One goal of professional development is to move away from “information showers” on teachers, to supporting teachers with resources to enhance their knowledge and skills through inquiry and critical reflection on their daily practices and its outcomes (Bredeson, 2003). As part of supporting teachers in enhancing their knowledge and skills, teachers need opportunities to learn by doing, read and reflect, collaborate with other teachers, and share what they see (Darling-Hammond & McLaughlin, 1995). Teacher participation in professional development can be connected to their work in real-life and give them opportunities to reflect on their practice and teaching. Darling-Hammond

and McLaughlin (1995) argue that professional development should be sustained, ongoing, intensive, and supported by modeling, coaching, and the collective solving of specific problems of practice. In the next section, I provide examples of professional development that utilizes concepts of effective professional development. First, I describe lesson study, a type of professional development that is ongoing, intensive, reflective, and supported by coaching and collective problem solving. Then, I describe Cognitively Guided Inquiry (CGI), a professional development program that provided teachers opportunities to change in terms of becoming ongoing learners.

Improving Classroom Practice: Japanese Lesson Study In Mathematics

Lesson study, which originated in Japan, has been accredited with success in improving classroom practice in mathematics (Fernandez & Yoshida, 2004). A lesson study is a teaching improvement activity where teachers jointly develop, teach, observe, analyze and revise lessons for their classes. As groups, teachers build knowledge about how students learn in their discipline and produce a lesson that is to be used by themselves and others. Although the original lesson study focused on mathematics instruction, the process of professional development has great learning opportunities for a variety of disciplines. In lesson study, as teachers gather concrete artifacts of student understanding (such as transcripts of student discussions) they are essentially accumulating assessment portfolios for their students, which can provide evidence-based insights into students' classroom performance and conceptual understanding (Chokshi & Fernandez, 2004).

Lesson study starts with collaboratively planning a lesson, where teachers come together to plan a lesson (Fernandez & Yoshida, 2004). During this stage, teachers first decide on an instructional goal that they wish to accomplish, such as encouraging students to learn from each other, rather than from only the teacher. Teachers share their ideas for how best to design the lesson by drawing on their past experiences, observations of their current students, the teacher's guide, and other available resources. The final product is a detailed lesson plan.

The second step of this process is for one teacher to enact the lesson in his/her classroom, while the other teachers observe (Fernandez & Yoshida, 2004). As the teachers watch the lesson, they refer to the lesson plan that was designed as a group.

The third step is a discussion of the lesson (Fernandez & Yoshida, 2004). The group comes back together to reflect on the enacted lesson, providing feedback, suggestions, and reactions. During this meeting, the teachers express challenges and changes that they would like to see next time. The teachers use the experiences from the classroom to introduce several possibilities for dealing with issues and come to an agreement about the design and future enactment plan.

The fourth and fifth steps are optional (Fernandez & Yoshida, 2004). These steps involves revising the lesson and re-teaching the lesson in class. This re-enactment will lead to an updated version of the lesson that reflects the new changes made.In the final step of a lesson study the teachers come back together to discuss their reactions to the second enactment of the lesson. In all

conversations, a written record is made for future reference and for reporting their work.

In Japanese lesson study, an advisor is chosen to bring content knowledge, pedagogical content knowledge and curricular knowledge to the group. The advisor provides access to information about recent research findings and theoretical information to the group, to relieve the teachers from having to access it themselves. In addition, the advisor makes connections between teachers by providing feedback that is informed from various classroom observations, as a way to help different lesson study groups learn from each other. The advisor is not meant to lead the group; lesson study groups are intended to be teacher led and situated in the teachers' experiences (Fernandez, 2002).

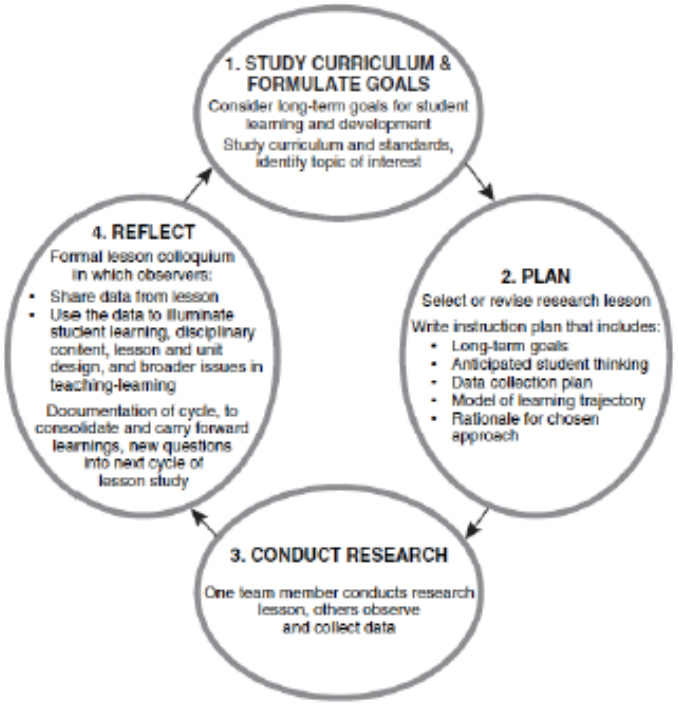

Figure 2-2: Japanese Lesson Study Cycle

Figure 2-2 graphically depicts the lesson study cycle according to Lewis, Perry and Murata (2006). Although lesson study shares many characteristics as other American professional development programs, the focus on planning lessons and live classroom observation makes it unique. This is very rare in American classrooms. As teachers plan lessons together, they include ideas that address how students will engage in the lesson, as well as the actual instruction. While planning, teachers also think about how they can collect data in their classrooms for future analysis and interpretation. After all teachers observe the live lesson, the teachers reconvene to share collected data, where they highlight student learning, content, lesson and unit design, and broader issues in teaching and learning. Later, the teachers take lessons learned and apply them to new lesson planning sessions.

Although lesson study has shown to be successful in Japan, American schools are skeptical of its practicalities and effectiveness (Chokshi & Fernandez, 2004). Chokshi and Fernandez (2004) argue that American schools need better education about the nuances and rationales behind lesson study to successfully implement it. American schools find professional development workshops structured similar to lesson study difficult because traditional transmission methods of professional development remain dominant. It is not part of American secondary school culture or structure for groups of teachers to repeatedly gather, collaborate, and critique each other on their teaching. Similarly, teachers in American schools are accustomed to the private and isolated nature of teaching, and are often uncomfortable with opening their

classroom doors to other teachers (Fernandez, 2002). In addition, American teachers are not bound by their districts to teach material simultaneously, meaning, each teacher may be on different topics at different times. Staggered enactment may make it difficult for teachers to collaboratively plan lessons.

According to Fernandez (2002), one of the greatest challenges to American schools is helping the teachers find a valuable learning experience in observing their own teaching. In Japanese lesson study, the teachers approach the process as a research experiment, where they ask questions, collect data on their teaching and interpret the data. Finally, teachers struggle to identify evidence in their classrooms to explore their research questions and many times lose sight of how it relates to their teaching.

Self-sustained and Generative Teacher Change in Professional Development: Cognitively Guided Inquiry (CGI) in Mathematics

Franke, Carpenter, Fennema, Ansell, and Behrend (1998) argue that in order to promote teacher learning, teachers need opportunities to understand the mechanism and process of their learning, in addition to the outcome of their learning. They argue that as teachers understand why students are successful, how student thinking develops, and how instruction can help students build on their current conceptions, understanding develops for the teacher, thereby creating potential for making connections between instruction and student learning. As teachers engage in practical inquiry, where they question and reflect on their practice with a specific focus, rather than searching for practices that "work," they come to understand principled ideas that can drive their practice and their continued practical inquiry, thereby leading to generative change.

Franke et al. (1998) continue to argue that principles of effective professional development do no inherently cause teacher change. Teacher change comes as the teachers construct an understanding of the principles in a way that not only helps them implement different practices, but also provide opportunities for reflection on practice. “Teacher change may not be captured in the experience that teachers have engaged in but in the meanings they have constructed,” (Franke, et al., 1998, p. 68). Franke et al. (1998) studied the kinds of changes teachers made during professional development and how those changes related to the fundamental principles of professional development.

In their study, teachers engaged in a program called Cognitive Guided Instruction (CGI). The theme of CGI was that children solve mathematical word problems by modeling the action and relations described in the problem. In this program, teachers engaged in learning that offered opportunities to build on their existing ideas to create continually changing organizing frameworks of children’s mathematical thinking. The program used video observation, problem solving, collaboration between teachers from different schools and grade levels, classroom observations by a mentor teacher, and interactions and support from the research staff. During this process, Franke et al. (1998) were able to understand how self-sustaining, generative change can occur among teachers.

Franke et al. (1998) found that when teachers used professional development opportunities to analyze and examine student thinking as a way to guide instruction, rather than imposing teaching strategies on students, they were more likely to accomplish self-sustained, generative learning. In addition, they

found that teacher growth was not automatic. Teachers needed time to grapple with student ideas and thought processes. Franke et al. (1998) learned that professional development that focused on understanding teachers' developmental patterns in knowledge, practice, and beliefs can be critical for learning how to plan and develop professional development programs for teachers.

Summary

Professional development is a much-needed practice in American schools. Although there have been studies of successful methods of professional development, as well as applications of research findings, like Japanese lesson study and Cognitively Guided Instruction (CGI), it is still unclear how teacher learning occurs during professional development. In the above studies, reflection was mentioned as an important component of teacher learning in professional development. As teachers form discourse communities, situate their learning in personal experiences and in group settings, and use distributed knowledge to construct new knowledge, they make use of reflective practices in the synthesis of their constructed knowledge. Wade, Fauske and Thompson (2008) and Zeichner and Tabachnick (1991) provided developmental stages of reflection that show how teachers shift in thinking about student learning. In this study, I applied ideas of teacher learning, reflection, and principles of effective professional development to support teachers in the enactment of inquiry-based discussions in high-school science classrooms. Because teachers continue to struggle with promoting scientific, open-ended, and dialogic discussions, I took the approach

of intense and sustained professional development to help teachers reflect on their practice and apply their learning to their teaching.

CHAPTER 3

METHODS AND ANALYSIS

This chapter describes the design, data collection and analysis techniques for this study. I begin by describing my role as the researcher and facilitator of the professional development. I then describe the context of the study and the study participants. Finally, I conclude with my analysis and interpretation techniques.

Study Overview

In this study, I described the ways in which a group of teachers reflected on their enactment of inquiry-based science discussions in their classrooms. To develop these descriptions, I collected and analyzed the conversations in four professional development workshops that took place over a period 12 weeks. During professional development, the teachers and I reviewed video of their enactment, analyzed educative elements of the curriculum materials, read and discussed research articles, brainstormed strategies and modified criteria for instruction. The teachers in this study participated in an iterative process of reflection and enactment; where teachers used the professional development workshops to inform their teaching, and used their experiences in the classroom

to inform their engagement in professional development. During this iterative process, the teachers and I continued to make changes and alterations to the embedded supports in the curriculum, in search of an efficient and useful way to support teachers in the enactment of open-ended science discussions while teaching.

I also interviewed the teachers two times; once at the beginning of the study, and once at the end of the study. I used the interviews to obtain more in-depth explanations of why teachers made instructional decisions and whether professional developed supported them. The interview data helped settle discrepancies between professional development conversations and enactments. They also provided confirmation of why teachers made certain decisions during enactment.

Role of Researcher

During the 2007-2008 school year, The University of Michigan[1] developed the curriculum used in this study. As part of curriculum development, we made major modifications to the teacher and student materials from the previous year. In a previous study, Alozie, Moje and Krajcik (2009) found that while teachers increased their attempts to engage in inquiry-based discussion practices where supports were offered, they relied heavily on traditional “recitation” formats, demonstrating that existing curricular supports were not developed enough to

[1] Aaron Rogat, Jennifer Eklund, and Nonye Alozie

support dialogic classroom interactions. That study showed that although the curriculum materials frequently supported teachers in areas such as the subject matter and representation of phenomena, support for classroom discussions was low. This dissertation explored this need. One goal of the curriculum was to give teachers supports that can be used in real-time, and we consulted and worked with teachers in this process. For this dissertation study, I worked with practicing teachers to think about how curriculum enactment can be supported with written supports and professional development.

I was the primary researcher of the study, where I obtained consent from the teachers to use their enactment, the professional development and interviews as data. During classroom enactment, I was an observer; I videotaped the discussions that took place. My interactions with the students during classroom enactment was limited to assisting the teacher during group activities and when asked.

As researcher, I inherently became a part of, and helped to shape, the settings in which I studied the teachers' learning. During my involvement in the professional development workshops, while trying to understand how and what teachers were learning, I provided guidance and support to the teachers by asking follow-up questions, using reflective toss with the teachers, and providing suggestions and potential explanations and interpretations of what teachers were experiencing. I mainly participated in professional development in two ways. First, I asked questions and made comments to elicit the teachers' ideas about what stood out to them while watching videos, reading research articles, and

analyzing criteria and the curriculum. I often asked the teachers to clarify or expand upon a comment that was made, or to explain any connections between what they read, saw in their videos and what was discussed as a group. Second, I participated in professional development by providing my own interpretations of what I saw and read, as well as suggestions of pedagogical strategies that might help a teacher struggling with an instructional problem. Although I contributed substantively to the professional development conversations, my goal was to allow the teachers to take ownership of the conversations. I provided the structure; making sure we stayed on task.

There are several constraints that came with being researcher and participant of the professional development workshops. There was initial distrust between practicing teachers and large research-based institutions. This distrust came from negative prior experiences with research institutions and created an initial feeling of caution and hesitation, for fear of being misrepresented. In addition, my contributions to the conversations led the discussions in directions that I suggested, rather than in directions that might have come from the teachers. Because of this, I cannot accurately report on what teachers knew, but rather what the teachers talked about. Finally, as researcher, I had a research agenda. This agenda focused my questions on particular topics, like specific discussions strategies, and limited conversations about other issues, like the length of the curriculum or issues with other activities in the curriculum.

Participants and Context of Study

Participants

I recruited 3 teachers and one high school science coordinator from a general professional development workshop for 13 teachers participating in the unit enactment. All 13 teachers participated in a genetics and genomic curriculum enactment project called Community Genomic Awareness. The teachers were high school teachers of Biology and participated in two professional development workshops that focused on inquiry practices and science content that I co-planed and co-conducted. The teachers worked in high schools in the Detroit Public School District and Flint School District, and did not necessarily have the same prior knowledge and amount of experience.

Three teachers were recruited based on their willingness to participate and availability. Teachers were sent an email introducing the study and explaining that their assistance is invited to improve the quality of instructional supports. The email was followed up by phone calls to the interested teachers. The phone calls reiterated the study and addressed teacher concerns and questions. At the second general professional development meeting, I met with the three teachers and science coordinator that agreed to participate, and talked about the study as a group. During this meeting, we coordinated dates and times. This meeting served as a project informational meeting, and not professional development 1.

This study focused on 2 out of the 3 teachers due to their consistent participation in the professional development workshops. *The How SIMILAR or DIFFERENT Are We From Each Other?* curriculum materials were enacted in

9th-, 10th-and 11th-grade Biology classrooms in two urban high schools in two large Midwestern cities during the 2007–2008 school year. The high school science coordinators for both districts selected the teachers based on teacher availability and interest.

Ms. Lewis was a Caucasian teacher, teaching in a predominantly African American school; composed of approximately 99% African American students. She used the curriculum in one 11th-grade general biology class. Ms. Ina was a Latina teacher, teaching in a predominantly African American school; composed of 99% African American students. She enacted the materials in two 10th-grade general biology classes. At the time that the unit was enacted, Ms. Ina had been teaching for 5 years, and Ms. Lewis had been teaching for 13 years. All school and teacher names are pseudonyms.

The classrooms were representative of the schools' populations. According to state standardized test scores, 15% of students at Nethering High School (where Ms. Ina taught) performed at proficient levels in mathematics and 12% reached proficiency in reading. Nethering recorded a 48% economically disadvantaged enrollment. Mulane High School, where Ms. Lewis taught, saw 8% of its students reach proficiency in mathematics and 24% in reading. Fifty-five per cent of the students at Mulane qualified as economically disadvantaged.

Curriculum Materials

We developed a high school curriculum for 9th/10th graders designed to support students' understanding of molecular genetics and genomics. Although the materials were designed around National Benchmarks and Standards (American Association for the Advancement of Science, 1993), we also inquired

with genomics experts to identify new and important ideas in genomics and genetics that were more current than the Benchmarks and Standards. Our project-based materials used *How SIMILAR or DIFFERENT Are We From Each Other?* as a contextualizing focus or driving question (Krajcik & Blumenfeld, 2006). The question asked students to make comparisons at many biological levels between themselves and other humans, and themselves and other animals. Due to the abstract nature of genetics and genomics content, and the lack of hands-on activities that would allow manipulation of genetic data in the classroom, the curriculum materials promoted discussions to help facilitate synthesis of scientific concepts and sense making. This inquiry-based approach to genetics and genomics instruction required teacher supports for engaging students in discussions that encouraged students to participate in a scientific community through sharing, rebutting, and justifying ideas through scientific evidence and reasoning.

In addition, the driving question of this curriculum was chosen to encourage rich discussions among students that may be uncomfortable, challenging, and potentially emotionally charged. Issues around human (and other species, such as primates) similarities and differences are often present in social conversations about race, religion, ethnicity, and a variety of sensitive and potentially contentious topics. Engaging in this curriculum can provide students with opportunities to begin to learn how to participate in evidence-based science conversations (that may have social implications) in meaningful ways (such as making policy changes).

The curriculum materials encouraged the teachers to engage the students in a variety of discussions spread over 6 lessons. The curriculum described discussions as an opportunity for students to make sense of the subject matter presented through activities, texts such as readings and video, and lectures. Engaging in rich scientific discussions not only gave students opportunities to synthesize science content they learned in class, but also had the potential to prepare the students for socio-scientific conversations that may take place outside of the classroom.

Shifting from the IRE (initiate-respond-evaluate) recitation pattern to open-ended discussions in science entails teachers learning how to recognize various kinds of discussions, how to use them effectively with their students and how to teach their students to participate effectively (Hess, 2004). Although learning to facilitate interactive discussions is challenging, it is an important area of expertise that all teachers need to develop (Rosaen, Lundeberg, Cooper, Fritzen, & Terpstra, 2008). Facilitating discussions requires paying attention to instructional elements, such as the science content, like transcription and translation, as well as conversational elements, like how questions are asked, the way the teacher attends to student responses, the way connections are made between student comments on different science concepts, and whether the classroom environment welcomes discussion (Goldenberg, 1992).The teacher must keep track of the progression of the discussion, who is interacting, what is being said, whether the appropriate connections are being made, and whether students use evidence to support their responses.

Teachers in this study reported that they and their students generally lacked necessary resources and support from the schools that could have helped the students participate in inquiry-based science learning environments. Because students and teachers lacked resources, rich scientific discussions in the classroom were difficult to enact. Hilton-Brown (2004) explained that ethnic minority students may have greater difficulty assimilating into the culture of the science classroom. He framed the challenges of assimilating into the science classroom as a product of linguistic conflict (Lee & Fradd, 1998), gender and ethnic identity dissonance (Brickhouse, 1994; Gilbert & Yerrick, 2001), and curriculum inappropriateness (Roseberry, Warren, Conant, & Hudicourt-Barnes, 1992). He argued that development of more equitable and inclusive norms of science instruction is a necessary direction in science education research.

The teachers in this study recognized the tensions mentioned in Hilton-Brown's (2004) study and were often wary of whether science education research could relate to their students, and how research in science education would characterize their schools and students. As the primary researcher of this study and the facilitator of the professional development workshops, I refrained from taking an evaluative stance of teacher enactment and students engagement in discussions. In my collection and analysis of the data, I intentionally chose not to increase their doubt of research by continuing to "identify" issues among the students and with the teachers' instructional practices. Instead, I took a similar stance to what Hilton-Brown (2004) described as needing to develop more "equitable and inclusive norms of science instruction," by focusing on how

teachers changed their instruction by tailoring it to their learning environment and how that aligned with their participation in professional development.

Context of Study

Professional Development Workshops

For this study, three teachers agreed to attend 4 additional professional development workshops about classroom discussions. The professional development workshops made this study an iterative process of curriculum development that took into account teacher views and ideas of how curriculum materials can support teachers. The meetings took place every 2-3 weeks for approximately 2-3 hours.

Workshop Goals

Workshop 1: The first workshop was a general introduction to classroom discussions and talked about the frequency of suggested discussions in the materials, focused on strategies that have been found useful, and encouraged the idea of dialogic interactions. I asked the recruited teachers for help in planning future materials that were educative for teachers. I explained the process of the professional development workshops, which are to review enactment and talk about what was useful, not useful, challenging and what can be changed for future enactments. We began by modifying a list of Project 2061criteria (see Appendix A) to a shorter and elaborated list that the teachers felt were most important and useful for their practice.

We also looked through the discussions of the unit and began planning how the teachers intended to enact the materials based on the given supports

and their modified criteria. Using the modified criteria, we talked about how the teachers wanted to change the educative features, so that it met their pedagogical needs. We shared past experiences with science discussions and talked about the kinds of changes we would like to see in the classroom and in practice. At the end, we came to an agreement of how to proceed with the next discussions for the next enactment period. In this agreement, we rearranged the format of the educative features to match the Project 2061 criteria and decided on background reading we would like to include as part of the professional development process. The workshop was videotaped.

Workshop 2: I continued with the workshops, reviewed enactment and talked about what was useful, not useful, challenging and what can be changed for future enactments. We reviewed the previous enactment period and focused on whether the educative features were useful for discussions. We discussed research articles (see appendix B for list of research articles) that the teachers and I read before the workshop. Research articles were chosen based on what the teachers chose for themselves. I also assigned a common article to read, based on what I thought would be helpful at the time. We talked about reservations and new insights with the articles. We watched videotapes of the teacher's enactment and used the modified criteria to talk through them. The teachers constructively critiqued and analyzed themselves with the aim of improving the materials and their practice. Teachers were less willing to critique one another, and I did not push them to. It also focused on helping teachers adopt the materials as their own by studying the materials, understanding the

goals of the discussions and how the educative features were to help achieve those goals. We discussed whether the initial attempts were successful and set goals for next enactments. Since the teachers were enacting the unit at different paces, I was not able to capture the same discussions in all classrooms. Instead, we came to an agreement of how to proceed with the next discussions in the next enactment period. In this agreement, the teachers set goals for themselves. For example, one teacher wanted to try using a public document, while the other teacher wanted to have less of a speaking role during classroom discussions. The workshop was videotaped.

Workshop 3: The third workshop was similar to the second. We talked about the research articles that we read. By this time, the teachers looked to the articles for guidance, and were less wary of their validity. We reviewed the previous enactment period and focused on whether the supports we talked about at the previous session were useful for discussions. This workshop was more comfortable and rich with ideas from the enactment and research articles. Teachers were more comfortable talking about issues they were having. They exchanged ideas and used the research articles to think about additional instructional strategies. The teachers also started to talk about social, political and institutional tensions that students were facing outside of the classroom, and started thinking about how their instruction could take student prior experiences into account when teaching and planning. At the end, we came to an agreement of how to proceed with the next discussions for the next enactment period. The workshop was audio and videotaped.

Workshop 4: The fourth and final workshop reviewed progress with the discussions and the materials. Time was taken to discuss challenges that teachers faced and we went over ways the materials helped alleviate some of those problems and how they may proceed in the future with discussions. Again, we discussed research articles and watched video of enactment. At this time, the teachers provided additional suggestions and comments about science discussions and curriculum development. During this final workshop, we completed our curricular support for discussions. We created an in-the-moment discussion guide for the teachers. We talked about how the discussion guide can be used while they taught and how it could be embedded in the curriculum.

Data Collection

I had 3 sources of data; professional development workshop videotapes, interviews, and teacher enactment. Table 3-1 summarizes the data I collected. Also, see Table 3-2 for Summary of Data Collection Sequence.

Professional Development Videotapes

The professional development videotapes captured conversations of the workshops. The video camera ran for the entire workshop and was positioned facing all members of the group. The professional development workshop videotapes were the main data source of this study. It is during professional development that teachers discussed challenges and successes, expressed concerns and goals, critiqued the curriculum materials and teacher enactment, and explored a variety of strategies that they considered important for engaging students in scientific discussions. Professional development videotapes also

revealed the teachers' reflective process as they used the various resources and engaged in dialogue.

I videotaped a total of four professional development workshops that occurred over twelve weeks. During the workshops, I recorded 8-9 hours (two to three hours per professional development workshop) of videos of teacher reflection, discussion of challenges and successes, expression of goals and concerns, critique of curriculum materials and teacher enactment, and exploration of discussion strategies.

Interviews

Each teacher participated in two 30-minute to 1 hour, one-to-one interviews with me. The interviews gave teachers a chance to go in depth about their thoughts and reflections about the enactment of science discussions and how curriculum materials supported them. Interviews were intended to reveal teachers' unique and personal experiences, views and perspectives on discussions, curriculum materials and the professional development workshops. They were private and I did not share information with other members of the professional development group. I also inquired about their involvement in the professional development workshops. I used the interviews as supporting data to the workshops.

The first interview explored teacher views about being supported in inquiry-based discussions. The second interview focused on the different features of professional development workshops and how they contributed to teacher learning and practice.

Teacher Enactment

I videotaped discussions in each lesson that were connected to particular activities or scientific phenomena. The discussions were analyzed based on the discussion practices that teachers expressed were important in the professional development workshops. The enactment served as indicators for the kinds of discussions taking place in the classrooms between the teacher and students. The analysis of teacher enactment looked for evidence to answer research question 2, “How do teachers’ enactment of inquiry-based discussions demonstrate their reflection practices, as shown in the collaborative professional development workshops?” Table 3-1 below shows the data that was collected, the frequency of collection, the participants of the data, and the purpose of each data source.

Data Source	Frequency	Participants of Data	Purpose
1. Planning Session: Videotape	At all of the planning sessions (4)	Focus Group (4 participants)	A video record of how teachers made decisions and planned enactment. Data for why the teachers wanted certain things to take place.
2. Interviews	Two times	Researcher:Teacher- 1:1	To identify individual teacher views of discussions, the use of educative materials to support discussions and the usefulness of the planning sessions.
3. Teacher Enactment	12 weeks	Teacher and classroom	To see what discussions looked like as communicated through the embedded supports and planning sessions.

Table 3-1: Data sources: How often data collection happened, the participants, and the purpose of data sources

The table below shows the professional development workshops within the context of teacher enactment. Each workshop occurred approximately 2 to 3 weeks apart; separated by videotaping of teacher enactment.

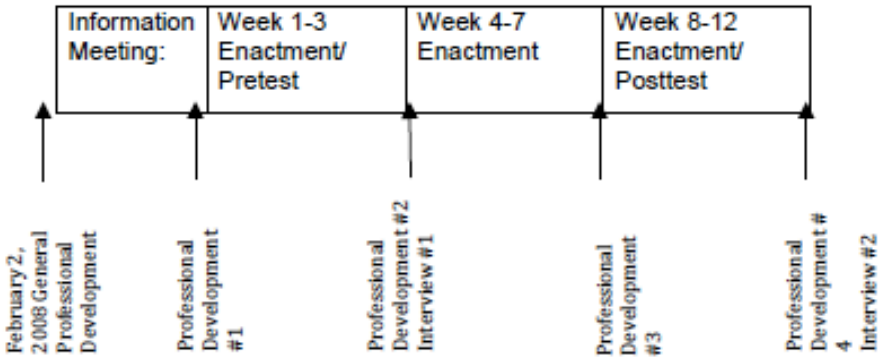

Table 3-2: Summary of Data Collection Sequence

Analysis and Interpretation Techniques

Validity and Reliability

Validity was established by data triangulation and member checking (Johnson, 1997; Krefting, 1991). Since qualitative research seeks to illuminate multiple perspectives, it is important that those perspectives be represented as accurately as possible. After each professional development workshop, I asked the participating teachers to evaluate my interpretation of the workshops. I explored previous interview data with the participants for differences in opinions and to clarify points that may not have been easily shared in the professional development workshops.

Reliability was established by having another researcher (not involved in this study) review the coded data as the analysis progressed. This reviewer re-

examined my codes and provided feedback on my interpretations and analyses of the data. He sometimes found inconsistencies in my findings and helped me redirect my focus. Finally, I looked for disconfirming evidence in my data to avoid unexplained inconsistencies (Erickson, 1986). Disconfirming evidence is data that do not fit with the other data, or are outliers.

Constant Comparative Analysis: Professional Development Workshops and Individual Interviews

Transcripts

Data coding happened after the video and audio recordings were transcribed. Transcripts allowed me to review the data multiple times and make written notes. I transcribed interview audio recordings, professional development workshops video recordings, and segments of the classroom enactments. To analyze recorded data, I transcribed spoken parts of the video and audio data sources (Green, Franquiz, & Dixon, 1997). In order to capture non-verbal parts of the events, I used a different notation, such as brackets, to indicate non-verbal communications. In my transcripts, I used a linear format of transcribing so that I did not privilege any speakers. Choosing a linear layout privileged the flow of talk through time (Green et al., 1997). I also used the present tense during transcription to indicate the routinization of events (Baker, 1997). Using present tense also helped with fidelity and accuracy of the events under study.

I transcribed the interviews in their entirety. I did not skip any portions. When parts of the interview were inaudible, I referred to my written field notes. Although the written notes did not represent the teachers' words verbatim, they provided an overall gist of what was discussed during the interview. While

watching the videotapes of the professional development workshops without playback, I took elaborate videonotes (Erickson, 1986), and then revisited specific parts of the tape to transcribe verbatim (Weiss, 1994).

Open Coding

Open coding is achieved by examining the transcripts word-by-word, line-by-line, sentence-by-sentence, paragraph-by-paragraph, or section-by-section. (See Appendix C for another detailed example of coding.) In this process, I read each document and coded section-by-section for themes. All codes were recorded in a separate file with their definitions. I kept track of how I made decisions about each code and any concerns that I had as the coding process progressed (Hewitt-Taylor, 2001; Strauss & Corbin, 1998). I coded the professional development workshops and the interviews using the same coding method.

I generated the codes from each data source rather than prescribing codes to them. As the analysis moved forward, new codes were added as necessary.

Categories and Subcategories

The open coding process was used to identify categories and discerning properties and dimensions of those categories (Strauss & Corbin, 1998). A category is an observation that is given a name (Strauss and Corbin, 1998). The category abstractly represents the happening, entity, or action/interaction that the analyst deems important in the data.

Categorization of the codes is the grouping of similar codes into an overarching theme, or category (Hewitt-Taylor, 2001; Strauss & Corbin, 1998). They depict the problems, issues, concerns and matters that are important to those being studied. The codes that are grouped into the categories may be used as subcategories, since they describe the categories. For example, codes such as “teachers have a sense of accomplishment” and “third person stance,” can be grouped under the category “analytical observation.” The original codes can now be used as subcategories, since they make the category more specific by describing the what and how of “analytical observation.” Subcategories are important because they give the categories meaning by denoting when, where, why, how and the type of phenomenon that is likely to occur (Strauss & Corbin, 1998).

In my analysis of the interviews and professional development workshops, the categories represented the role that the teachers played or the stance that they took during the professional development workshops. They also represented the result of the professional development workshops, where each category represented a solution to problems framed in the workshops. Through reflection, the teachers transformed concerns and issues into experimental solutions to problems that arose while teaching.

Properties and Dimensions

Properties and dimensions provided richness and description to the abstract categories (Strauss & Corbin, 1998). In my study, each subcategory was given properties and dimensions. Properties and dimensions differentiate

subcategories from one another and give them precision. Strauss and Corbin (1998) describe properties as “general or specific characteristics or attributes of a category” (119), namely, the amount, duration, timing, type, process, location and persons involved, and dimensions as “the location of a property along a continuum or range” (119). The previous example had the category “Analytical Observation” with subcategories of “teachers have a sense of accomplishment” and “third person stance.” The subcategories have the property “focus of observation” to help delineate the subcategories. A teacher may focus their observation on themselves or on their students. To further qualify the subcategory “third person stance,” I used the dimension of “positive vs. negative.” For example, the property “focus of observation (student)” may have the dimensions of positive or negative focus. The final description looks something like this: A teacher was an analytical observer while focusing on students, and had positive perceptions of the students while observing.

The use of properties and dimensions helped with the formation of patterns as groups of properties aligned themselves along various dimensions. When incidents were compared to one another, incidents or events that were similar were grouped together. This process was helpful in moving the analysis towards an understanding of what was happening in the data.

Axial Coding

According to Strauss and Corbin (1998), the purpose of axial coding is “to begin the process of reassembling data that were fractured during open coding” (124). After I reached a point where properties and dimensions were difficult to

detect, I axial coded as a way to establish relationships and linkages between categories, subcategories and properties. This step helped me further explain the phenomena (Strauss & Corbin, 1998). Although axial coding is described here as a distinct step that happens at a particular moment, in my analysis of the data, axial doing happened during various stages of my analysis. My process of axial coding resembled what Strauss and Corbin (1998) describe below:

1. Laying out the properties of a category and their dimensions.
2. Identifying the various actions/interactions, conditions and consequences associated with a phenomenon.
3. Relating a category to its subcategories through statements denoting how they related to each other.
4. Looking for cues in the data that denotes how major categories might relate to each other.

Through axial coding, I was able to understand the complexity of the real-life interactions of the participants in the study. Axial coding brought together the process and structure/conditions of a phenomenon. Process (how something happened) tells the actions/interactions over time of persons, organizations, and communities in response to problems and issues. In this study, I analyzed the process of reflection while using the various resources of the professional development workshops over time. Structure/conditions (why something happened) create the circumstance in which events related to the phenomenon are situated. Here, the resources of the planning sessions provided the structure and conditions of the reflection. Together, process and structure/conditions provided the how and why a phenomenon happens.

For example, using the above example, I connected the category “Analytical observers” with its properties by determining the process of this action

as being a third person observer of themselves and each other. I coded the conditions of the analytical observer actions as the resources: video observations and the research articles. During the planning sessions, these resources in particular were effective in helping teachers move through the reflection process.

Selective Coding

I used selective coding to link categories into a coherent whole (Strauss & Corbin, 1998). It is during selective coding that I integrated and refined the categories that I have found during open coding; although this process continuously happened as data was being collected and analyzed. As part of the integration process, I decided on a central category (Strauss & Corbin, 1998). The central category consisted of all the products of analysis condensed into a few words that seem to explain what the study is about (Strauss & Corbin, 1998). The central category must relate to all other categories, appear frequently in the data, should be general enough to include other areas and can explain variation and the main point made by the data.

Once the central category was described, I checked for internal logic and consistency (Strauss & Corbin, 1998). In doing this, I looked for categories that needed to be further fleshed out, checking that the abstraction of the data now fits the raw data. This process of selective coding helped me make comparisons within and across data sources.

Observation Evidence: Teacher Enactment Videos

To analyze classroom enactment, I looked through transcript data to find patterns first by teacher, then across teachers. The teacher enactment was an

indicator of how teacher reflection of enactment was represented in their instruction. To understand how the teachers' enactment resembled solutions discussed during the professional development workshops, I looked for evidence in their enactment (Schneider & Krajcik, 2002). The evidence was based on the discussion practices as described through research and modified in professional development (see Table 3-3). I videotaped each teacher enactment 6-12 times (1-2 times a week for 12 weeks) for 1-2 class periods each. While videotaping, I paid attention to teacher instruction and student participation in the lessons. I watched for congruity between professional development goals and the actual enactment. I also looked for incongruent enactment to explore places that the teacher made alterations or omissions to the goals.

The first discussion practice was making knowledge explicit. The analysis question was "How do teachers promote the use of evidence and scientific reasoning to support claims?" The types of evidence that I looked for were instances where teachers encouraged the use of evidence gained from activities, and/or reading to support their answers (McNeill, Lizotte, Krajcik, & Marx, 2006).

The second discussion practice was asking questions and providing non-evaluative follow-ups. The analysis questions were how do teacher questions incorporate student reflection, negotiation, use of claim, evidence, reasoning and the confrontation of prior knowledge, and how does the teacher extend the discussion with follow-up questions? Evidence of this practice included asking non-recall questions, like open ended questions or reflection questions (Chin, 2007). Evidence for the second analysis question were instances when

teachers/students used follow-up questions, such as “How do you know that,” during a discussion (Nassaji & Wells, 2000).

The third discussion practice was supporting student communication. The analysis questions were what roles or positions do students play during discussions, what type of public document do the teacher provide to keep track of the goals and points made, and is reflective toss used? Evidence for the first analysis question included whether the students were bearers of knowledge or demonstrators of knowledge (Moje, 1997). Evidence for the second analysis question included using a class chart on the board, overhead, or any type of public display (Magnusson, Palincsar, & Templin, 2004). Evidence for the third analysis question was teacher use of questions that required the students to reconsider other student questions and responses (van Zee & Minstrell, 1997).

Finally, the fourth discussion practice was discussion etiquette. The two analysis questions for this practice were, was the teacher a facilitator and manager of the discussion, and does the teacher work at the intersection of everyday language and scientific language? Evidence for the first analysis question was whether the teacher managed the discussion or controlled the discussion. Evidence for the second analysis question was teacher use of a metascript, revoicing, and seeding. I also looked at whether the teacher was a collective memory, and/or restated the driving question (Magnusson, et al., 2004).

The evidence stated here helped me make comparisons to the enactment plans made during the professional development workshops. Since professional

development helped the teachers reflect on their instruction in various ways, I looked at their enactment to determine whether enactment matched their reflection process. In cases of deviation, I looked for evidence to explain this deviation. I looked through interview and professional development videotape data to understand why teachers chose a different approach from what was discussed originally. This analysis led to some understanding of the complexities of teaching inquiry-based discussions, and how professional development may have to change to support teachers in those complexities.

Discussion Practices	Analysis Questions	Evidence
1. Making knowledge explicit	1. How do teachers promote the use of evidence and scientific reasoning to support claims?	1. Students use an activity or reading as evidence to support their answers
2. Asking questions and providing non-evaluative follow-ups	2A. How do teacher questions incorporate student reflection, negotiation, use of claim, evidence, reasoning and the confrontation of prior knowledge? 2B. How does the teacher extend the discussion with follow-up questions?	2A. Asking non-recall questions 2B. Teachers/students use follow-up questions
3. Supporting student communication	3A. What roles or positions do students play during discussions? 3B. What type of public document do the teacher provide to keep track of the goals and points made? 3C. Is reflective toss used?	3A. students are bearers of knowledge or demonstrators of knowledge 3B. Use of a class chart on the board, overhead, or any type of public display 3C. Teacher uses questions that requires the student to reconsider something they asked
4. Discussion etiquette	4A. Was the teacher a facilitator and manager of the discussion? 4B. Does the teacher work at the intersection of everyday language and scientific discourse (metascript, revoicing, collective memory, seeding, restating driving question, and using prompts)?	4A. The teacher managed the discussion or controlled the discussion 4B. The teacher used a metascript, revoicing, seeding, was a collective memory, and/or restated the driving question

Table 3-3: Literature Based Discussion Practices

The table below is a summary of how each research question was analyzed.

Research Question	Analysis Plan	Purpose of Analysis
How do collaborative professional development workshops promote teacher reflection?	Open coding; Categories, subcategories, properties and dimensions Axial coding Selective coding	To find themes and patterns to help explain teachers' process of teacher reflection during the planning sessions. To find themes and patterns to help describe the most relevant resources that helped facilitate teacher reflection.
How do teachers' enactment of inquiry-based discussions demonstrate their reflection practices, as shown in the collaborative professional development workshops?	Observation evidence from enactment videotapes	To find instances of teacher enactment that reflect the professional development planning sessions and curriculum materials.

Table 3-4: Research Question Analysis Plan

Triangulation of Data

The professional development workshops, interviews, and teacher enactment were the primary data of this study. From these data, I used patterns that emerged to provide explanations for teacher reflection and enactment congruity. The patterns found in these sources will be compared to the patterns found from the classroom observations. The observation data will show the kinds of practices that teachers engaged the students in. Together, the data sources will show what the enactment looked like based on how teachers planned their enactment after reflection in professional development.

Memos and Audit Trails

Memos

Memos helped me gain analytical distance from the materials being analyzed and pull the data into concepts that tell a story (Strauss & Corbin, 1998). Memos also helped me think through some of the initial connections that I

noticed during axial coding throughout the analysis. They were a written record of evolving thoughts and allowed for future comparisons with data interpretation.

Audit Trails

In this study, I had a large volume of data, including videotapes of the professional development workshops and enactments, interview recordings, transcripts, notes about the context of the study, methodological decisions, and data analysis procedures. The audit trail helped me keep track of the decisions that I made throughout the analysis process. It helped maintain consistency and organization (Rodgers & Cowles, 1993).

CHAPTER 4

USING RESOURCES IN PROFESSIONAL DEVELOPMENT TO ENGAGE TEACHERS IN REFLECTION: UNPACKING ISSUES AND SOLUTIONS OF PRACTICE TO INFORM INSTRUCTIONAL GOALS

Overview of Chapter: Using Reflection to Inform Teacher Learning Through Professional Development

This chapter examines how practicing teachers used professional development workshops as an opportunity to reflect on their enactment of scientific discussions in a science classroom. The research question guiding the next two chapter analyses is: *What kinds of reflection opportunities are afforded by collaborative professional development workshops?* This part of my study highlights various resources that the teachers used to facilitate, promote, and unpack the process of reflection, as well as, set instructional goals for themselves.

This chapter shows that professional development can give teachers opportunities to reflect on their practices in practical and applicable ways for their teaching, as well as in informative ways for science education research. Professional development not only focused on improving instruction, but also provided opportunities to generate instructional goals by providing teachers with

opportunities to watch each other, make comparisons, discuss concerns and issues, propose solutions, and then test the solutions in future enactments. The results show that of the various resources used, the reading and discussion of education research articles, and video observation, were often the springboard for conversations that led to changes in reflection and the development of an instructional intent.

In this chapter, I present results on how the resources appeared to help the teachers talk critically of their practice; in ways that were personal and specific to their practice and observable to the researcher. In addition, the resources contributed to the practical side of teaching; giving teachers immediate feedback while they determined goals for enacting inquiry-based discussions. I show that reading research articles and observing videos seemed to initiate topics for conversation. Video gave teachers opportunities to make comparisons between personal instruction and other teachers' instruction. Reading research articles gave teachers opportunities to explore their pedagogical questions and search for alternative ideas and approaches. As the researcher and participant of the professional development workshops, I helped teachers realize those opportunities by encouraging them to be critical of their instruction and talk about instructional changes through follow-up questions and reflective toss. Over time, teachers expressed the kinds of discussions they wanted to accomplish in their classrooms; including student engagement and the types of strategies they would use.

Overview of Reflection as an Overarching Theme

The goal of the professional development workshops was to develop pedagogical skills in inquiry-based discussion through sustained, collaborative professional development. As the professional development progressed, the ideas behind reflection changed and became more complex.

Professional development ultimately appeared to help teachers learn to reflect on levels beyond themselves and what they saw in the classroom, and broader social and personal issues pertaining to the students and teaching. The professional development not only promoted changes in teacher reflection on the development of student content knowledge and inquiry skills, but it also encouraged teachers to question their teaching practices, think about the implications of what they taught, and to consider how the greater social and educational community influenced student interaction in the classroom as they planned for instruction.

Analytical Observation Through Professional Development Resources

In this chapter, I describe how professional development resources helped teachers reflect on different aspects of their teaching, thereby contributing to how they approached teaching and planned for instruction. Videos and research articles, in particular, seemed to provided teachers with opportunities to reflect on their practices through the process of framing problems and proposing solutions.

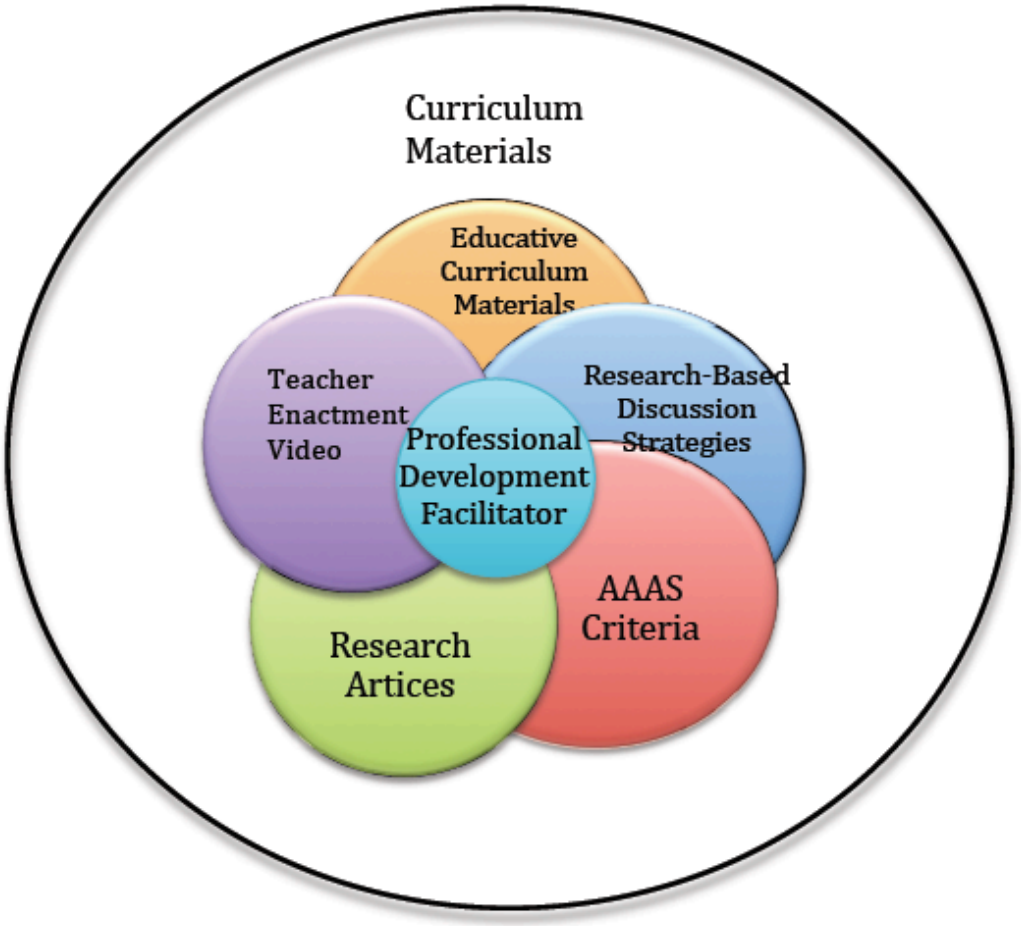

Figure 4-1: Using Resources in Professional Development

Figure 4-1 shows that together, the resources used during professional development played a role in the iterative process of reflection and classroom instruction. At the center of the interaction is the role of the facilitator. The facilitator was responsible for making connections between resources, while remaining consistent with the curriculum materials (the outermost circle). During professional development, I, the facilitator, incorporated each resource into the workshops to provide opportunities for reflection that was curriculum focused and linked to the teachers' classroom practice. In this figure, I show that professional

development was a blend of various resources that were held together by a common curriculum. I worked to make connections between the resources in order for the teachers to think critically about their practice and incorporate new ideas and practices discussed in professional development into their classroom practices.

In this study, I focused mainly of the use of research articles and the observation of teacher enactment video. Videos helped teachers make comparisons across and within practices, while research articles helped teachers explore their questions about pedagogy. Each resource helped the teachers unpack reflection in different, but intertwined ways; although the resources had individual contributions to reflection, their combined effects seemed to inform the teachers' decision-making process and approach to teaching. As the teachers observed videos of their enactment and discussed research articles, they framed problems and proposed solutions based on what the teachers learned from the resources. Their intertwined and combined contributions provided opportunities for rich reflective discussions about practice and how to improve instruction.

In this chapter, I first present results that show how research articles helped the teachers explore their pedagogical questions. Figure 4-2 shows how research articles created different opportunities for reflection and how those opportunities contributed to formulating problems and proposing solutions. (Chapter 5 presents results for how reading and discussing research articles also seemed to help the teachers put forward solutions that demonstrated a change in approach to instruction.) I also show how research articles seemed to help

teachers make instructional comparisons among themselves. Figure 4-3 shows how video also appeared to help the teachers frame problems and suggest solutions while they reflected on their practice. Finally, I conclude the chapter with a summary of the results.

Research Articles to Explore Questions of Pedagogy: Using Research Articles to Talk About Instructional Issues

As teachers talked about instructional issues and problems, the research articles helped teachers highlight pedagogical challenges. According to Schon (1987) and Wade, Fauske and Thompson (2008), framing problems is one step of the reflection process. The reading of research articles served as a tool for teachers to explicate instructional issues and explore different research-based solutions. Figure 4-2 shows that as the teachers discussed their instructional challenges, they responded in three ways. 1) The teachers met the research articles with skepticism and wanted to confront the literature. During professional development, the teachers expressed their disappointment with how education research portrayed urban schools, teachers, and students. They explained that research in education characterized educational issues as being a problem located within the students and teachers, rather than recognizing social and systemic contributions to educational issues. As researcher and facilitator of the professional development, I encouraged the teachers to continue reading the articles each week. Over time, teachers demonstrated a change in their perception of the articles, and used them as references for framing instructional problems. 2) The research articles also helped the teachers describe their instructional issues with specificity. Teachers used the articles to talk about what

they were seeing in their classrooms. 3) Finally, the teachers used the research articles as a source of instructional comparison. While teachers read the research articles, they talked about how they were similar and/or different from their practices.

Although the teachers were initially skeptical of research articles, reading them ultimately seemed to help the teachers think and talk about their teaching differently. The conversation below is an excerpt from a discussion about the research article *Co-constructing Inquiry-Based Science with Teachers: Essential Research for Lasting Reform* by Keys & Bryan (2001). In the excerpt, the teachers talked about how research in education often portrayed urban schools in a negative light. The initial intent of reading the articles was to give teachers opportunities to learn about teaching strategies that research had shown to be effective and useful. However, during one professional development workshop, Ms. Lewis expressed her disappointment in research that misrepresented her school, and the lack of intervention from the greater educational research community.

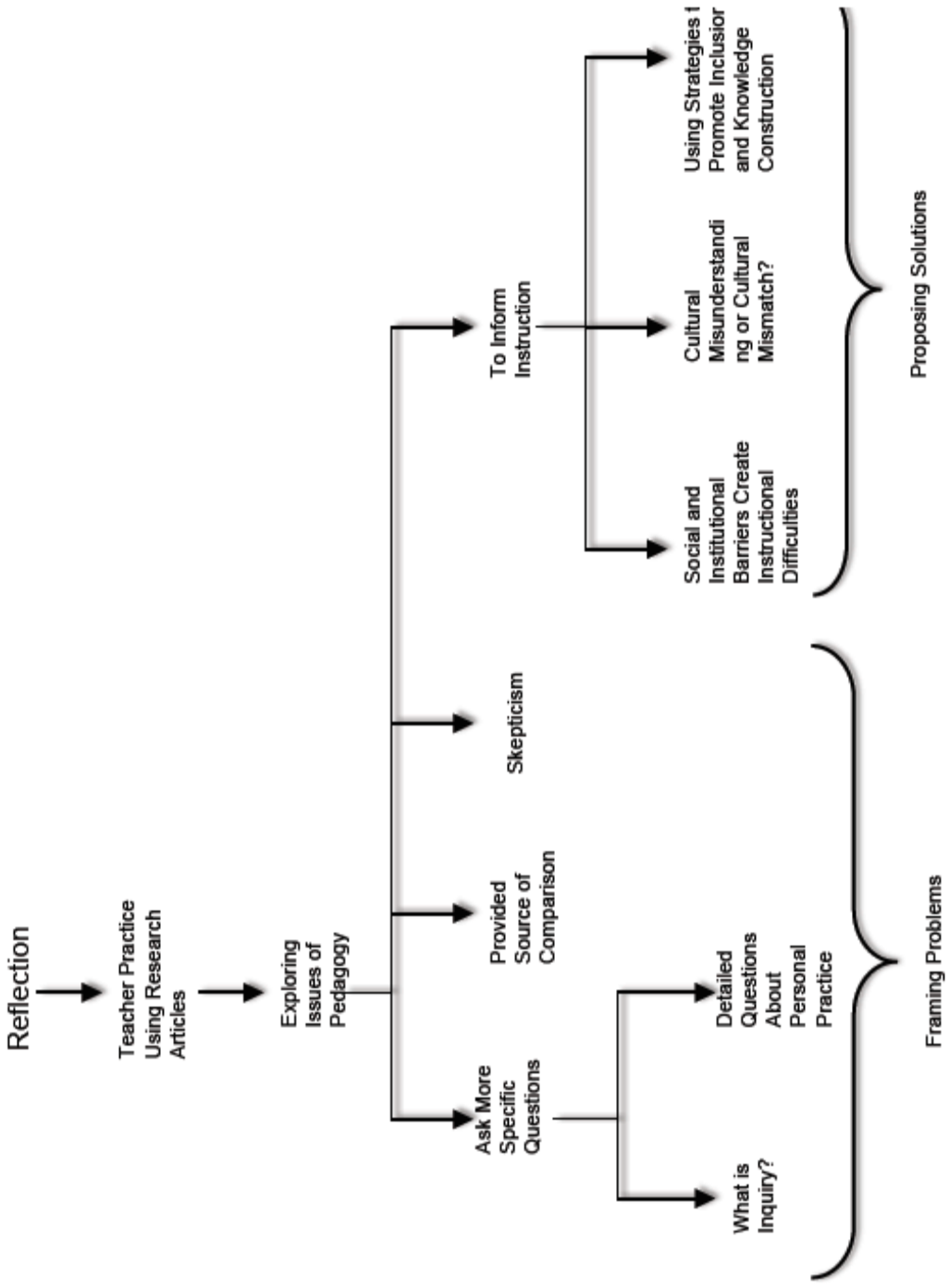

Figure 4-2: Unpacking Reflection Using Research Articles

Ms. Lewis: Like that study where Detroit schools get forced elimination in terms of graduation, and it's because they regard people that don't graduate from the same school they started in 9th grade as a drop out.

Researcher: So, if they changed schools, they are dropouts?

Ms. Lewis: Yeah, so like our valedictorian is like, "You know I'm a drop out? Because you know I did 9th grade at Cass Tech and now I am here." I'm like, "Yep, you don't count."

Researcher: How does that even make sense though? Why would they do that?

Ms. Lewis: Because it's based on the way schools used to be and it doesn't recognize the transient nature of the way students move around. Some of my students are on their 4th or 5th high school in the district depending on the family member they live with and the district just doesn't recognize that. So, they are saying we have a 25% graduation rate, and yes our graduation rate needs to be improved, but it's not 25%. Looking at that, I don't know how many students will graduate this year, but I would guess half of them didn't start at Mulane.

Researcher: That's weird that they would do that. All school districts don't do that do they? Is that a common thing?

Ms. Lewis: This was done by some study.

Researcher: Oh, that's annoying.

Ms. Lewis: The thing is we look at this and know that these numbers are not accurate, but no one is saying to the public that the numbers are wrong and what I am finding to be true is that people hurt by the study are saying that the numbers aren't right. But people have this image of Detroit, its just bad.

The teachers expressed doubt in the reliability and validity of science education research in urban schools. In the excerpt above, Ms. Lewis described a study she read about the Detroit Public School District. She expressed disappointment and frustration with research in education. In this excerpt, Ms. Lewis recalled a conversation with one of her students, and said, “Yep, you don’t count” to the student. In this phrase, she sarcastically told the student that the educational system did not care about her. She went on to criticize research by saying, “they don’t’ take into account the transient nature of the way students move around,” and “the district just doesn’t recognize that.” Such phrases indicate that Ms. Lewis did not completely trust the validity of the study and that the article did not understand her school community. Furthermore, Ms. Lewis concluded her explanation in lines 28 to 31, where she explicitly explained that the research was incorrect, and “we” (the school community) knew that, yet “no one” (other education researchers) intervened to correct the false statements made about her, her students, and her school. She ended with an implication of the study, saying that such research only perpetuated negative stereotypes of urban schools and hurt people in the process.

In the same conversation about the same article, Ms. Ina expressed her skepticism about large research universities. In the discussion below, she spoke specifically about inquiry-based instruction and its enactment in urban schools.

Ms. Ina: I thought it was interesting. They kept mentioning that more research is needed in how inquiry-based science is implemented in urban settings. I think that’s why I was interested in it, but they never resolved anything. They just stated that we need it. Each classroom has its own culture and each teacher brings their own culture in, and I think

often times these inquiry-based lessons are developed by other people that don't have the same experiences; and that's, when I did a problem-based unit that was part of "University M." I felt that it didn't seem to work all-that well in the classroom because my students had different experiences. And I don't know what the answer is and I would really like to know what the answer is.

The teachers expressed that research in education was conducted by people who did not understand urban school culture and potential curriculum inappropriateness for students. In the excerpt above, Ms Ina's comments were similar to Ms. Lewis's. She referred to University M; a large research-based and curriculum development university. In lines 4-7 she said that developers of inquiry-based lessons did not have the same experiences as the students who used them and therefore could not relate to the students through the curriculum materials.

Ms. Ina and Ms. Lewis both expressed concern with research in education and its implications for urban schools. In both cases, Ms. Ina and Ms. Lewis argued that education research in urban schools was misinformed, lacked understanding of urban school culture, and did not work in the classroom. As a result, they did not completely trust the research.

Over time, conversations about the research articles moved from skepticism to asking more specific questions and making comparisons between their teaching and the research. As the teachers continued to talk about problems they faced in the classroom, they used the research articles to ask focused instructional questions, and talk about how the research applied to their teaching. Although Ms. Lewis's and Ms. Ina's explanations demonstrated doubt in the articles, they continued to read them and look to them for instructional

support and assistance. Below is an excerpt from the same conversation. In this excerpt, I asked Ms. Ina a follow-up question; pressing her to be more specific about her problem.

Researcher: What's the question?

Ms. Ina. Well, so how to implement this problem-based learning or inquiry-based science effectively with my students.

Researcher: So Ms. Lewis, you have been teaching for a while, and you have done some inquiry things. Besides this unit, have you done inquiry units? How did you find the enactment in your classroom?

…

Ms. Lewis: The biggest thing with them is structure. I try to provide them with a structure that's organized and known to them so that when they come in, they know that these are the things that are going to happen. Once I have structure in place and it's comfortable, then it's easier to try different things. I do try to take their interests into account.

Research articles seemed to help the teacher talk specifically about instructional issues about inquiry. My follow-up question encouraged Ms. Ina to think more carefully about the issue that she was facing in the classroom and frame it into a question. She specified that she wanted to know how to implement problem-based learning or inquiry-based science effectively after reading the Keys and Bryan (2001) article. Previously, she mentioned that inquiry did not work in her classroom because student experiences did not match that of the curriculum developers. Here, she is searching for an alternative way of enactment. She did not abandon the idea of inquiry-based instruction, but was looking for suggestions for effective instruction.

In my follow-up move, I asked Ms. Lewis to use herself as an example for Ms. Ina. I encouraged comparison among the teachers, with the intent of promoting collaborative problem solving. Ms. Lewis responded with her experience of teaching through inquiry-based methods; stating that structure, comfort, and taking students ideas into account are important (this idea is explored further in the following chapters).

In a similar conversation during another professional development workshop, Ms. Lewis started a conversation about the definition and process of classroom discussions. In the excerpt below, we discussed the article *Classroom Discussion: A Method of Instruction and a Curriculum Outcome* by B. E. Larson (2000). In this conversation, Ms. Lewis started by stating her reservations about the article before reading the article, but realized that it not only helped her think about her teaching more critically, but also helped her generate questions that could potentially improve her teaching.

Ms. Lewis: I read the Larson article and basically the reason I looked at it was because there were 5 or 6 different teachers and they asked them what they thought discussion was and to rank them. And there were 16 goals, and then it was back down to 4 or 5. They didn't answer any of my questions, but they raised some interesting questions and gave me a lot to think about so…

Researcher: What kinds of questions did you have?

Ms. Lewis: What I expected them to say is what discussion is. I was going to be prepared to argue with them, that's not what discussion is, but they didn't actually say what it is, so I was pleased at the end that they said that they didn't really know what it was. Their point was that when people say discussion, they mean question answer format. And a lot of teachers do that. I was hoping to see the many formats and how

often each was used, which they didn't do, but it was my motivation for choosing that one. Because I look at discussion in my classroom and realize that sometimes my goal is not what happens and wondering how often that happens to other teachers. But that wasn't answered.

Researcher: So were you able to resolve any of your questions from reading the article?

Ms. Lewis: I don't know that it resolved them, but it made me more curious. And I think it's a good thing.

Ms. Ina: More curious about what?

Ms. Lewis: A lot of things. Things I hadn't even considered before. And about… it made me think about what I am doing in my classroom and see what other teachers are doing in their classroom and how I can alter what I am doing. All kinds of things.
…
Researcher: So, how did you think their discussion definitions or examples matched what you were… what you came in with initially?

Ms. Lewis: I think that they really did a nice job looking at the different kinds of discussions. These five different types. And I looked at them and said, "Oh sometimes I do this, and sometimes I do this." I think I tend to move back and forth between them, maybe more than some people do. That's one of the things that I was curious about; that I would like to see.

Over time, the teachers seemed to develop trust in what they could learn from the research articles, thereby creating opportunities for reflection on their practice. In the excerpt above, Ms. Lewis initially questioned what she could learn from the article when she said that she was ready to argue with the article in lines 9 and 10, but realized that having additional questions was a "good thing" (lines 21 and 22). She explained that because the article did not explicitly tell her

what a discussion was and how to do it, she was impelled to search for the answers on her own by watching other teachers. Furthermore, it encouraged her to think about her own practice, how it compared to other teachers, and how she could change (lines 26 to 28). This article also helped Ms. Lewis think about her own practice in terms of the research, by showing her that she moved back and forth between discussion types, perhaps contributing to her goals not being met through discussions, as she said in lines 15 and 16.

In this conversation, Ms. Lewis shifted from skepticism to using the research article as a source of comparison. She talked about thinking about her own classroom and whether her instruction aligned with what was described in the article. She went on to talk about comparing herself with other teachers. When asked a follow-up question by Ms. Ina, she began to talk about specific issues that she encountered in her classroom. In the previous excerpt, I asked follow-up questions to encourage the teachers to ask explicit questions about their teaching and the articles. In the above excerpt, Ms. Ina also asked a follow-up question; asking Ms. Lewis to identify what made her curious. From Ms. Ina's follow-up question, the conversation moved to using detail to describe issues and/or questions, resulting in Ms. Lewis' clarification of what made her curious.

The research articles provided teachers with opportunities to exhibit the reflective teacher attributes of efficacy and flexibility (Colton and Sparks-Langer, 1993). Although Ms. Ina and Ms. Lewis expressed reservations towards research articles, they showed that they were willing to consider multiple perspectives on inquiry and the enactment of discussions. Ms. Lewis was interested in exploring

how other teachers enacted discussion after reading the Larson article. Ms. Ina was interested in learning about how Ms. Lewis enacted inquiry in her classroom after reading the Keys and Bryan article.

Although the teachers often expressed doubt in the articles for various reasons, professional development gave the teachers a venue to talk through their reservations, think about and identify issues in their practices, and share experiences with each other in relation to the articles as they progressed towards talking about instructional approaches and modifications. Over time, the teachers found the articles to help them generate additional questions and problems about their teaching, make instructional comparisons, and begin to explore solutions.

Video Observations: Comparing Instructional Practices

Using Video to Talk About Instructional Issues and Accomplishments

Similar to research articles, video observation played an important role during professional development. Watching video of enactment created additional opportunities for teachers to highlight and describe their personal issues with greater specificity and recognize instructional achievement. The video was intended to give the teachers insight into each others' and their own teaching from a third person standpoint, rather than to model exemplary teaching strategies, unless the opportunity arose. (However, should a teacher demonstrate a strategy with expertise, it was discussed and encouraged in the other classrooms.)

Figure 4-3 shows how video afforded teachers with opportunities to frame problems and talk about various solutions. Similar to research articles, the act of

watching videos appeared to encourage the teachers to make comparisons among themselves. Through comparisons made, the teachers highlighted and specified problems they faced in the classroom. During this process, they pointed out issues that were specific to their practice. However, while making comparisons, they began to acknowledge instances of success in their teaching and in student engagement. Furthermore, enactment videos served as a window into the teachers' practices as they compared themselves to each other. As the teachers looked into their enactment, they generated additional questions about their teaching and talked about potential solutions.

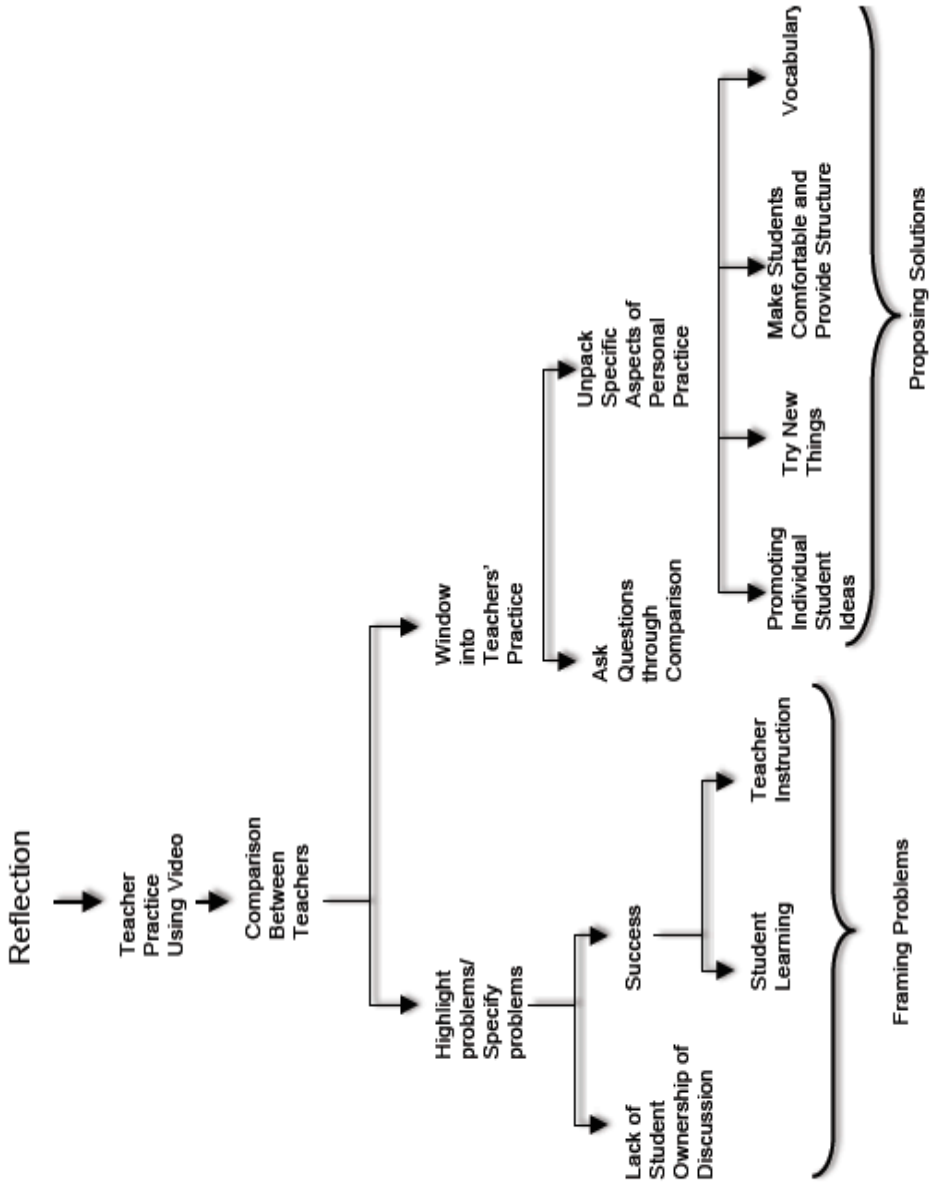

Figure 4-3: Reflection Using Video Observation

In the following excerpt, Ms. Ina highlighted three specific ideas that she did not notice before watching video of her discussion enactments; the lack of student ownership during discussions, instructional accomplishments, and

student learning (see Figure 4-3). The excerpt below is from a conversation during the second professional development workshop about a video of Ms. Ina enacting a discussion about the risks of inheriting genetic diseases and passing them to offspring.

Researcher: Ok, so let's talk about it for a minute. I liked several things. I liked how you sat down in the class with the students and had another student take the responsibility of writing on the board and calling on students.

Ms. Ina: I was thinking I wanted them to take it over more, so, I was disappointed that I kept butting in. It's certain things I didn't hear before. I heard someone say, "What's the difference between lactose and lactase?" I didn't hear that then.

Researcher: I don't think it's bad to intervene to help them along. It's good for them to have you push them a little to help them articulate themselves. I think that you butting in a little helps to encourage them to keep going. Were you constantly using strategies when you were doing this?

Ms. Ina: I wanted them to take over and discuss with each other.

Watching the video afforded Ms. Ina the opportunity to draw attention to areas that she wanted to improve. In the excerpt above, although I started the conversation by pointing out what I thought was an effective teacher move, Ms. Ina chose to focus on the areas that she wanted to change. In lines 5 to 7, she spoke of wanting the students to take ownership of the discussion more, and that she wanted to intervene less. She went on to say that she didn't hear certain things before watching the video. Ms. Ina pointed out that she did not notice that a student was struggling with differentiating between the terms lactase and lactose, which are two important vocabulary words in the curriculum. (In the

section, *Using Video to Connect Instructional Issues to Solutions*, I discuss this idea further.) Video seemed to give Ms. Ina a chance to analyze herself by making comparisons between in-the-moment teaching and teaching she viewed on video. As a researcher and participant in the professional development, I wanted to encourage Ms. Ina, by telling her that intervening was not always negative. However, Ms. Ina continued to point out her areas of desired instructional improvement, such as giving students ownership of the discussions.

The next excerpt shows that although video observation encouraged teachers to talk about instructional issues, it also helped them recognize successes in their teaching. The use of video during professional development can not only help teachers track student engagement and student thinking (Sherin & Han, 2004), but can also give teachers opportunities to develop confidence in themselves and their students, and as a result, encourage them to achieve instructional changes and improvements. Below, Ms. Ina expressed surprise at the amount of student engagement in her classroom, when initially, she stated that inquiry-based instruction did not work in her classroom. In this discussion, the students participated in an open-ended discussion on an ethical issue. In the video, Ms. Ina instructed one student to lead the discussion by creating a public record on the chalkboard.

Ms. Ina: I enjoyed watching them. I didn't know that they were that engaged. Then seeing it on video is different. And I guess you have a million things going on in your mind, because you have to juggle so much.

Researcher: And I know you have a lot to think about all at once.

…

Researcher: So Ms. Lewis, did you have any reactions to the video? What did you think about watching the things she did, how did you …

Ms. Lewis: I would like to try some of the same things. I am curious to see how my kids react. Because where your kids are now, mine aren't. But I would like to get them more towards that. I think it's going to be a battle, but I don't care. I always win.

Video allowed the teachers to "see" themselves while teaching, and notice the progress students made in response to instruction. In the above excerpt, Ms. Ina said that she enjoyed watching her class. In previous conversations, Ms. Ina commented on difficulties of teaching with inquiry-based methods in her classroom. Here, she formed a different opinion of her students. This change in opinion came after viewing video of her own enactment. Ms. Ina stated in line 2, "Seeing it on video is different."

Furthermore, Ms. Lewis used Ms. Ina's enactment as a teaching exemplar. Ms. Lewis used the video observation as an opportunity to make comparisons between her teaching and Ms. Ina's teaching. From this comparison, Ms. Lewis set goals for her own teaching, saying that she would like to try some of the same things (line 10). She also took into consideration how her students might respond to new instruction (lines 10 to 12). Although vague, Ms. Lewis identified an issue with her students' progress. In the previous section, Ms. Lewis stated that she wanted to see how other teachers enacted discussions and hoped that the articles would offer examples. Here, Ms. Ina's video provided an example, which encouraged Ms. Lewis to consider new ways of teaching.

In the following interview excerpt, I asked Ms. Ina specifically how the videos helped her reflect on her instruction. In this conversation, Ms. Ina articulated how watching videos contributed to her change in teaching approach.

Researcher: We kind of talked about his a little bit. And this might be a little repetitive, but how did you use those videos to reflect on your own practice? Like, how did it help you think about what you were doing?

Ms. Ina: For me, when looking at myself, it made me realize that I was accomplishing something, and that the students were learning, because when you're a teacher and you think that your not accomplishing something and the students aren't learning, then you're just spinning your wheels, which is what I thought I was doing. But, it wasn't what I saw on the video.

Researcher: So, the video helped increase your confidence in what you were doing and helped you feel like you were accomplishing something?

Ms. Ina: And it made me have a better view of my students.

Researcher: How did that help you… did that change you at all? And when you came back to class and thought, wow, my kids are actually…

Ms. Ina: Yeah. I think that my approach and how I viewed them changed. I just saw that. Because in day-to-day teaching, you're caught up in so much nonsense that things that are important seem to be muffled and diffused and it's not brought out to the forefront. Whereas looking at a video, you don't have any of those emotions or anything that you're dealing with. You are just looking at it straight and then you see the value of the students and of what you're doing. And so if I do have a bad day, I have a tendency to tell myself more now, "Ok, that's just the way you feel, and it'll pass. That, you know, there are things, positive things, happening.

In the above excerpt, there is a change in Ms. Ina's attitude. She stated that she had a "better view of her students" which contrasts her initial

descriptions of “immature,” “they don’t even try” and “they are really immature” (explained more in Chapter 5). After watching videos of her enactment, her descriptions changed to “the students are learning,” and “you see the value of the students.” Through video observation, Ms. Ina made use of the opportunity to critique herself and her teaching approach. Not only did she use video to talk through different parts of her teaching, but she also took the opportunity to analyze student participation. Video observation and discussion also seemed to give her incentive to press forward when teaching became difficult. Although teaching through inquiry-based methods was stated as difficult by the teachers, being able to recognize accomplishments through video observation may have helped encourage forward movement and progress. Ms. Ina said in lines 25 and 26 that she told herself “it’ll pass. That, you know, there are things, positive things, happening.”

As video helped teachers highlight successful teaching moments, it also helped the teachers change their perception of students through third person analysis of themselves. Ms. Ina mentioned being able to separate herself from emotional distractions during teaching when watching video (lines 22-24). In lines 5-9 she argued that video made her accomplishments visible; she did not believe that she successfully engaged students in discussion until she watched her video. Similarly, in the excerpt below, she commented on how she perceived herself and her students after watching video.

Ms. Ina: It’s hard to see what’s going on when you are teaching.

Ms. Lewis: You get tunnel vision.

Ms. Ina: I heard somebody say, “I have a question, I have a question,” and it was never addressed… and when I think about the class, I don’t think of a class that’s functional. But when you see portions like this, I think, “Gosh, I have a classroom. I have students. I am a teacher.”

Similar to Ms. Ina’s comments during the interview, she and Ms. Lewis stated that in-the-moment teaching creates “tunnel vision,” making self-evaluation and critique challenging. Video, on the other hand, appeared to have removed the barrier of tunnel vision; allowing them to “see what’s going on” in the classroom, begin to discuss problems and solutions, and recognize successes in teaching and student learning.

Using Video to Connect Instructional Issues to Solutions

Not only did video observation provide opportunities to formulate questions about their teaching, but they also encouraged the teachers to discuss solutions to their problems. Video observation created a window into the teachers’ practice as they discussed solutions. It also generated two responses from them (see Figure 4-3); 1) Video observation provided another source of comparison, and 2) by watching video, teachers were able to talk through different aspects of their personal practice, in order to make instructional decisions. As teachers talked about different solutions, I categorized their discussions about their teaching into four parts- the use of vocabulary, experimenting with new strategies and discussion types, maintaining an atmosphere of structure and comfort, and promoting individual student ideas in a discussion.

The excerpt below demonstrates teachers using the video to make comparisons between classes, raise an issue, and discuss potential solutions to the problem. In the excerpt, the teachers and I talked about Ms. Lewis's enactment of a discussion on proteins that produce skin color.

Ms. Lewis: The things that's amazing about this group of kids is that they can keep track of everything that everyone is saying. Its like, what, what?

Ms. Ina: It looked that way. Especially the one that was laughing at the student that couldn't pronounce the words correctly.

Ms. Lewis: This has been going on since the beginning. Because before we even discussed melanin, she would come up to me and say, "What's that word that begins with M that gives skin color?" So, every day she would be Melalil, Melalinin (mispronounces the words several times). She wants so badly to say it right, but she can't.

Ms. Ina: The same thing happens in my classroom. They have to address it like a foreign language. Like how they teach foreign languages. What do we do, just keep saying it over and over?

Researcher: What do you think?

Ms. Ina: Well, I didn't even think to address it until I saw your (Ms. Lewis) video. Terminology.

Researcher: Well, I think, have them repeat it and be consistent with it. Are they spelling them right? Or is it pronunciation?

Ms. Ina: It's both.

Ms. Lewis: With Danielle, she thought there was an extra syllable in it. You will see in her booklet at the top of the page, Melanin. She is really good-natured and the people at her table want her to get it right. So, I don't even have to say anything.

Ms. Ina: I think you have to be aware of it. I never considered it enough and it's something I need to be aware of.

In this excerpt, the video served as a way for Ms. Ina to delineate different parts of her teaching through comparisons with Ms. Lewis's teaching. After watching Ms. Lewis's video and listening to her talk about issues of vocabulary, Ms. Ina recognized the same problem in her classroom. Ms. Ina responded to Ms. Lewis's story by inquiring ways to address vocabulary during discussions. Ms. Ina mentioned that teaching science vocabulary was similar to teaching foreign languages and asked how to address it. She mentioned that her students also struggled with vocabulary, but she had never thought about how to address it in science until they watched the video.

Recall, in the section *Using Video to Talk About Instructional Issues and Accomplishments*, Ms. Ina commented on student differentiation between vocabulary words (lactose and lactase) while the discussion was happening. In that conversation, Ms. Ina stated that it was not until watching the video that she noticed this problem. Now, Ms. Ina raised the question of how to manage it. Ms. Ina decided that simply being aware of vocabulary was part of the solution to her problem. Watching the video gave Ms. Ina the opportunity to sift through the complexity of the classroom and attend to a specific instructional problem. This is similar to what Sherin and van Es (2009) report when they describe professional vision as being a combination of selective attention and knowledge-based

reasoning. Rather than describing the events in Ms. Lewis's classroom, Ms. Ina interpreted what she saw. Ms. Ina noticed that enacting discussions required a new focus on understanding the teaching of science vocabulary and called into question the use of foreign language techniques and strategies. In a previous discussion, Ms. Ina broadly questioned inquiry-based instruction in urban classrooms, and here, has moved to considering a specific aspect of teaching through science inquiry.

It is important to note that the *teachers* started to direct the conversation to specific issues. During this conversation, I did not raise this issue, but instead suggested repetition as a way to help students practice vocabulary and directed the issue back to the teachers. Ms. Lewis used her classroom experience to talk about students helping each other with pronunciation. Not only were teachers changing their analytical focus from being descriptive to interpretive, but they were also identifying issues, raising them for discussion, and discussing potential solutions on their own.

Similarly, in the conversation about inquiry-based instruction, I redirected Ms. Ina's question about "how" inquiry-based instruction is enacted to Ms. Lewis and she responded by explaining that students needed to be given structure and comfort. Once structure and comfort were established, Ms. Lewis argued that trying new things became easier. This idea was revisited in the next professional development workshop. There, we returned to our conversation after watching Ms. Ina's enactment on video. Ms. Lewis expressed apprehension to trying open-ended discussions in science classrooms. The research article by Larson (2000)

sparked a conversation about trying different types of discussions. Ms. Lewis was unsure of how to incorporate open-ended discussions in her classroom.

Ms. Lewis: And that's why, especially when there are questions about the other subject areas, because I could see some discussions actually better in something like a Social Studies class or an English class. You know I look at these and think, you know, I would like to try these, but I don't know how they fit into my curriculum, and I would like to see someone else do it. Either do it well, or do it badly. So I can say, I want to do it like that, or I don't want to do it like that.

Researcher: Right. Which ones were the ones that you could see… that you thought were interesting, but you weren't sure it would fit?

Ms. Lewis: What did they call it? I guess some of the open-ended. The ones where they talk about a discussion going on for 20 minutes and no consensus being reached. And, for my students, that would be really frustrating. Like, we just went through the ethical discussion, and they are still mad about it.

Researcher: Really?

Ms. Lewis: 'Well, what's the right answer?' 'Well, there isn't a right answer.' 'Well, there has to be a right answer, this is science. There's a right answer.' 'Well, there isn't.' 'So, you're going to tell us when we get done what the right answer is?' 'No, there is no right answer.' 'Ok, we're done, are you going to tell us what the right answer is?' 'I told you.' And, I would like to do more of that with them, because I think it's an important life skill. But, then I also wonder if they are doing this in some of their other classes because the way they came kind of tells me that they're not. Or they wouldn't have been so frustrated. It seemed like they were doing it for the first time.

Watching video of enactment helped the teachers talk about how to address specific aspects of their teaching; in this case experimenting with new discussions while maintaining a comfortable learning environment. Video served

as a window into practice and provided opportunities to find solutions for instructional issues. From watching Ms. Ina, Ms. Lewis was able confront her discomfort with open-ended discussions and talk about experimenting with a new type of discussion and strategy. The excerpt shows that Ms. Lewis was interested in trying new types of discussions in her classroom, but was apprehensive. The articles we read reviewed different kinds of discussions, but were situated in social studies classrooms. Although Ms. Lewis wanted to implement the discussions described in the article, she raised issue with their effectiveness in a science classroom and discomfort with trying something that might not work (lines 2-5). She talked about the difficulty she had with her students' need to have one right answer (lines 19-23); which is not uncommon in science classrooms (Lemke, 1990). She argued that she wanted students to engage in open-ended discussions more frequently, but thought it would be frustrating (line 14). In lines 5-7, she said that she would like to see someone else do it; model good or bad instruction in order to visualize what an open-ended discussion would like in a high school science classroom. This request welcomed another opportunity to view and discuss a video.

In a previous excerpt, Ms. Lewis commented on Ms. Ina's enactment of an open-ended discussion, saying that she would "like to try some of the same things." She said that she was curious to see how her kids would react because she believed that her students were not ready to interact in dialogic ways yet. Watching Ms. Ina's enactment allowed Ms. Lewis to observe another teacher

attempt to enact a discussion. In the next excerpt, we discussed Ms. Lewis's enactment of an open-ended discussion using a public record.

Ms. Lewis: This is the first time having students make the public document. It really helps. It's really helpful.

Ms. Ina: I was thinking that I didn't use the public document with this (discussion). I liked what I saw.

Ms. Lewis: Yesterday we talked about proteins before that first reading. I'm ready, I'm ready. I wasn't going to do it this time, but sure. Go for it.

Researcher: Something I noticed was that you explained to them what you wanted to see different. Even just in doing that, there was an instant switch. They were beginning to address each other more. I don't think any one person raised his hand. Just explaining, "This is what we are going to do," there is that instant mental switch of, "Oh, this is what we are doing." Have you had to explain that again, or was it that one time.

Ms. Lewis: It was just that one time. They were pretty receptive to it.

Researcher: So when you start a discussion, do you just jump into it, or do you say you are going to have a discussion? How does it start?

Ms. Lewis: Well, the way I usually start my class is I spend the first couple of minutes saying what we are going to be doing. I usually say, "These are the 4 goals of today. I would like to do this, this, and this. Ok, we are done with goal one and we are moving to goal 2." That's how they're used to things being. They love to mimic me.

Researcher: So you don't necessarily introduce the new activity?

Ms. Lewis: It depends on how the first one ended. Sometimes there is a natural transition. Sometimes I do and sometimes I don't. And it depends on the kids too. Some need that signal. Otherwise they are lost, "When did we finish?"

Researcher: Is there anything you would do different next time?

Ms. Lewis: One thing is, I won't do public document on the board. I would use the overhead and reuse the transparencies. I share the classroom, so I can keep my public record.

Watching video helped the teachers talk about ways to make changes in their classroom discussion enactments. In the excerpt above, Ms. Lewis talked about using the public document as being a new, but a helpful practice. Watching Ms. Ina implement this strategy and discussion encouraged Ms. Lewis to begin to unpack certain aspects of her own teaching. She was also interpretive, rather than descriptive, as she spoke about her enactment. In lines 22-26, Ms. Lewis mentioned what students were "used to," which is similar to her argument about creating a comfortable and familiar environment in the classroom. She maintained the concept of comfort while she ventured into new instructional and potentially uncomfortable territory. She also talked about the needs of her students and how it would influence her enactment. At the end of the conversation, Ms. Lewis talked about how she would continue to shape the discussion and use of a public record for her classroom.

Finally, video afforded teachers with opportunities to talk about increasing student participation in science discussions. As they continued to watch themselves and each other on video, they became more interested in trying complex discussion practices, like increased student-student interactions. Ms. Ina and Ms. Lewis both stated that they wanted students to challenge what they heard in class, and not blindly accept everything. They wanted their students to

not only challenge the teacher, but also challenge each other. They both expressed concern with this idea for different reasons. Ms. Lewis argued that her students were uncomfortable questioning her authority as a teacher in class. Ms. Ina complained that her students did not challenge each other, but instead conformed to a unanimous class idea.

In the excerpt below, the conversation centered on encouraging students to express their individual ideas as an aspect of teaching that needed addressing. Both teachers talked about conforming to some standard of knowledge. In Ms. Lewis's classroom, the students considered the teacher to be the source of knowledge; knowledge that they should reiterate. In Ms. Ina's classroom, the students looked to a student in the classroom as their source of knowledge. Ms. Ina and Ms. Lewis wanted to encourage individual thought and ideas, and therefore an increase in contestation of ideas through discussion.

Ms. Lewis: It's ok. If all they do is talk because they all want attention, I mean, I am ok with that. But, getting up to actually disagree with me makes some of them really uncomfortable. They are glad to tell me what they think. But I think they tailor it to what they think I want to hear. And so I say, "Why do you think that," or "Tell me more." "Because that's what you want to hear."

Researcher: Ms. Ina, I think you had that problem too at first, where you would ask them a question and they repeat something you or someone else said. And you had to get them to stop doing that and get them to say what they are thinking. I am wondering if that is a similar issue. I mean did you, before you had them doing discussions, were they doing similar things to what Ms. Lewis is talking about; where they tailor what they say, or did they disagree with you and say what was on their mind. Was that something that was always there?

Ms. Ina: I think they are still willing to disagree, but follow each other. Maybe if there are a couple that are outspoken, they will just go with that. That's what I get angry about. But, I think that the ones that are outspoken were always willing to be outspoken. And everyone else will just follow along. It happened yesterday. I asked them to draw slides on the board, and they had missed the sickled cells, and I asked them if that is what they saw. "Yeah, this is what I saw." "Really?" I went back and pointed it out, "Oh yeah, I did see that." "Well why didn't you say that?" They were still doing that yesterday.

Researcher: So its definitely hard to get them saying what's really on their mind?

Ms. Lewis: Many times if a student wants to challenge me, it's not in front of the whole class. They will quietly ask me a question and I'll say, "Why didn't you bring that out? Are you worried about hurting my feelings?" I'm not sure they know why they do it, but they seem to have this idea that that's how to do it. I think it might be because that's how they would like to be challenged. I've been trying to reinforce that. It's a challenge.

Through professional development conversation, the teachers expressed difficulty in encouraging students to challenge the information they learned in class. In an earlier conversation, Ms. Ina stated that she wanted the students to take ownership of the discussions so that she could step out more often. This idea became more specific as Ms. Lewis commented that students tailored their class discussion contributions in order to meet what they believed were her standards (line 3-5). She mentioned using follow-up questions for clarification and elaboration of ideas, but her students persisted on modifying their ideas to fit what they thought she would want to hear. Again, Ms. Lewis mentioned comfort as a part of how her classroom functioned. In this case, student discomfort prevented them from engaging in discussions through argumentation for fear of upsetting the teacher. Later, she explained that her students might have avoided

public confrontation and disagreement with her because they wanted to be treated in a similar manner.

To push the conversation forward and encourage the teachers to talk to each other and collaboratively explore this issue, I turned to Ms. Ina for her thoughts. I reminded her of students in her classroom that exhibited similar behavior and encouraged her elaboration. In Ms. Ina's interpretation of her students' behavior, she noted that students followed each other; one student in the class set the standard and the other students followed. In both cases, Ms. Ina and Ms. Lewis wanted their students to have individual thoughts, even if it meant disputing the "classroom standard." Not only did the teachers state that they wanted to transfer control of the discussion to their students, but they also wanted the students to contribute individual ideas and thoughts to the discussion. Nonetheless, Ms. Ina continued to struggle with classroom conformation, and Ms. Lewis battled against being the authoritative standard.

To encourage student engagement and expression of ideas, Ms. Lewis talked about her use of a think-pair-share strategy, or what she called "ascending discussions." In the excerpt below, Ms. Lewis talked about how she worked to increase student participation

Researcher: So you found that just starting on a small scale then branching out helps involve more of the students…

Ms. Lewis: Well, I think it increases, for some of them, it increases their comfort level to the point where they feel like maybe they aren't comfortable talking in front of the whole group, but they can talk to a partner, and they can talk to the table, and over time, the more they see it done, the more comfortable they become, and I have people who at the beginning wouldn't have said anything if they were on fire, I mean literally, they really

wouldn't have. And I don't think I can say that about anyone except for one person in the class. And even he, he won't participate in discussions, but he is talking to me more. Which I regard as something of a success.

Discussing issues of student engagement helped the teachers brainstorm strategies that could increase engagement and participation in discussions. Ms. Lewis said, in lines 5-7, that ascending discussions helped the students by gradually increasing the number of people they talked to. She argued that as the students learned to talk to more and more people, over time, they would be more comfortable with larger class discussions.

After watching a video of Ms. Lewis enacting a discussion on melanin, we returned to the issue of vocabulary. During this conversation, we talked about repetition and consistency. Ms. Lewis again advocated making the students comfortable with structure and familiarity. Recognizing that repetition, consistency, comfort, and structure were important parts of teaching for the teacher and students, trying new things became less daunting. I then revisited the idea of encouraging students to challenge each other and asked Ms. Ina and Ms. Lewis how they would address that, having watched two additional videos that day. In the excerpt below, Ms. Lewis talked about how she planned to promote disagreement in her classroom.

Researcher: How about things like levels of participation? Ms. Ina, yours challenge, and Ms. Lewis, yours are respectful but have a hard time challenging.

Ms. Lewis: They don't have... the good thing is they don't have trouble challenging each other. They need to work on challenging me.

Researcher: So it's you they need to challenge?

Ms. Lewis: I think so, yeah. They are quick to call each other out.

Researcher: How would you change what you do?

Ms. Lewis: They have this mentality that if it's written down some place, it must be right. I want them to challenge authority. Whether that's me, or the book.

Researcher: How do you plan to push that forward?

Ms. Lewis: I think its repetition. Just keep poking, poking and poking. I think if you want to change something that's deeply engrained, you need repetition. Especially if you say, don't believe anything I say, because I tell you not to believe anything I say.

The idea of repetition was presented as a potential solution for encouraging disagreement in discussion. While discussing the video, Ms. Lewis said that her students made progress in their ability to have a discussion with no definite answer (not shown in the above transcript). She said,

> They were much more happy about it than the first time. The first time, they were mad. There wasn't a right answer or wrong answer, and they were much more ready this time to not come to a conclusive answer; which I thought was progress.

Ms. Lewis recognized that her students bought into the idea of a standard right answer and therefore did not contest ideas that came from the teacher or science textbooks. She also recognized that encouraging students to question authority was a contradiction in itself, but yet consistently pushed this idea to the students. Eventually, her students became familiar with disagreement and welcomed it. Ms. Lewis demonstrated her ability to tease out parts of her practice

through video observation, and think about how to address them in future enactments.

Video observation and discussion opened opportunities for the teachers to show different attributes of a reflective teacher (Colton and Sparks-Langer, 1993). While framing and describing their issues with discussions, they commented on students developing skills for life. Ms. Ina and Ms. Lewis were concerned with developing students into citizens that can interact and communicate within their communities. In addition, the teachers showed that they were willing to talk about different ideas and perspectives, as well as explain their reasoning to the group. The video itself offered a teacher's perspective by showing how they enacted a discussion. As teachers watched each other and themselves, they made comparisons, asked questions, and modified their instructional ideas while making decisions for future enactments.

Summary

Professional development workshops gave teachers opportunities to be reflective on their practice. Videos and research articles provided teachers with opportunities to reflect on their practices. Their conversations revealed different aspects of their instructional issues and potential solutions. When Ms. Ina and Ms. Lewis read and discussed research articles, they formulated problems by comparing their practices with each other, overcoming skepticism, and asking questions about inquiry-based instruction and learning. Video observation helped teachers highlight problems within their practice, such as a lack of student ownership of discussions, but also highlighted successful teaching and student

engagement moments. Video observation also helped them look into their personal practices and ask specific questions about it. Through professional development conversations, the teachers expressed several instructional goals and modifications that they wanted to enact in their classrooms. Based on these conversations, instructional goals included:

1. Increasing student ownership of discussions
2. Increasing student engagement during discussions
3. Less teacher intervention during discussions
4. Incorporating a public record on the board during discussions
5. Increasing appropriate scientific vocabulary during discussions
6. Experimenting with different types of discussions and discussion strategies, such as ascending discussions
7. Maintaining structure and comfort when enacting discussions
8. Increasing individual student ideas
9. Promoting students to challenge the teacher and each other during discussions

The use of resources during professional development encouraged rich conversation that moved beyond correcting student inabilities to looking into different types of pedagogy that could address instructional issues.

The analysis in this chapter also demonstrates that incorporating resources into professional development can create opportunities for building reflective characteristics, such as flexibility and consciousness (Colton and Sparks-Langer, 1993). With the assistance of a facilitator, teachers can not only identify issues of teaching, but also interpret classroom events and consider solutions based on past experiences and research-based ideas.

CHAPTER 5

A CHANGE IN TEACHER TALK THROUGH REFLECTION: RE-ESTABLISHING AN APPROACH TO TEACHING

In this chapter, I show that professional development appeared to create opportunities for changes in how teachers talked about approaching solutions to instructional issues. Video observation and discussion helped teachers talk about instructional issues in practical ways; narrowing solution brainstorming to conversations about events that happened only in their classrooms. Adding research articles to the professional development workshops allowed the conversations to address different issues related to teaching that were not necessarily obvious from video observation.

In the beginning stages of professional development, teacher conversations located problems within the students and on wanting strategies presented in educational research. They stated that they wanted strategies to increase student engagement in inquiry. By the end of professional development, teachers refocused their conversations to include locating classroom problems within the students' experiences and social structures, and away from perceptions of student inabilities. The teachers' approach to finding solutions also shifted from searching for remediation strategies (i.e. think-pair-share) to

understanding the students' prior school and personal experiences as a way to guide instruction (see Table 5-1). In Chapter 4, I listed instructional goals the teachers described during professional development. In this chapter, I show that as teachers made plans to change their instruction, their conversations also changed in terms of how to approach enactment to achieve their goals. Teachers wanted more than strategies to help student have inquiry-based discussions. They explored their understanding of issues pertaining to the students as a vehicle for guiding the students through appropriating inquiry-based discussion skills.

Using Strategies to Promote Inclusion and Knowledge Construction: "Inquiry is Difficult to Teach; I Need a Plan-of-Action."

Before we incorporated the reading and discussion of research articles in the professional development workshops, teacher conversation focused on acquiring strategies that could increase student participation and promote knowledge construction. The excerpt below is from the first professional development workshop and all teachers were present. In this conversation, the teachers talked about learning how to engage students in classroom discussions that encouraged students to develop skills and knowledge of inquiry processes and behaviors. This conversation took place before we looked through several AAAS criteria with the goal of condensing them into guidelines for instruction. The criteria that we used helped categorize the kinds of learning that teachers would like to see happen in the classroom and how the teachers could help facilitate learning. As we discussed the criteria, teachers mentioned their

struggles and challenges, giving us opportunities to organize and address them in the next 3 professional development workshops.

Ms. Kline: I know I am not a very good discussor with the kids. It's more of I throw out a question and somebody answers it. Sometimes it feels like a free-for-all in there, and everyone starts yelling. (Laughs)

Ms. Lewis: Have you been watching my class? (Laughs)

Ms. Kline: I don't know how to harness… some of the kids want to discuss, you know, for some of the kids, that's just time to be a free- for-all. I would like to know how to harness them into a meaningful…

Researcher: So you are looking for some kind of structure; some kind of order to your class, so-

Ms. Kline: Some type of plan, so that I know that I am going to maybe have them do a survey thing, like we did, stand and… I'm not good at that sort of thing. I guess more guided, for me.

Ms. Lewis: I'm kind of in the same boat. I am looking for some different strategies to try from time to time.

Ms. Ina: I'm looking for the same things as well. And I'd like to really effectively engage them and to teach them to find a way of bringing that in. And also, it's easier for me to say that this is how it is, because that's the way I was taught. I want to stand back and let them build that information so that they come up with the answer.

Ms. Kline: Everything is going to that inquiry-based and I think you should have discussions based on inquiry. It's hard to get all the kids engaged. Usually, its just 3 or 4, and the others are talking about their prom dresses or whatever.

Ms. Lewis: I've been kind of spoiled too because I have probably the most motivated kids in the school, and I know that won't always be the case, so, I can build up some skills for when I got back to the other students. Because you can't always treat all your classes the same.

Professional development seemed to present opportunities for teachers to initiate conversations about instructional problems they faced while enacting inquiry-based discussions. In this excerpt, the teachers talked about some of the challenges that they faced while engaging students in inquiry-based discussions. Although each teacher commented on something different, the common wording throughout this excerpt is, "I am looking for…" Each teacher is looking for something additional to what they have already done and already know.

The teachers agreed that they had a common problem; they were all interested in being better discussion facilitators. Each teacher described it in different ways. Ms. Kline started the conversation by stating a problem, "It's like a free-for-all" and "Everyone starts yelling" (lines 2-3). She then stated that she wanted to know how to harness her students so that they could participate "meaningfully" in a discussion. I asked a follow-up question and suggested that they needed "structure" or "order" (line 11). Ms. Kline clarified her need and said that she needed a plan and guidance. Ms. Lewis agreed and added to the list of needs, stating in line 18 that she wanted strategies to try from time to time. Ms. Ina agreed and continued to explain that she needed strategies to engage her students and teach them in effective ways (lines 21-22). She also talked about wanting to teach differently from how she was taught; wanting students to take

the lead during discussions and build their own knowledge, while she “stood back.”

The teachers experienced a tension while teaching. Ms. Kline argued that engaging students in inquiry-based discussions is required, but difficult, because many students were not interested in participating through discussion. In such situations, the teachers struggled with knowing what to do in the moment of teaching and hoped to learn/develop skills for knowing how and when to engage students in inquiry-based discussions. In this excerpt, the teachers named several problems; “a free-for-all,” “everyone starts yelling,” and wanting to step back while students constructed knowledge. When talking about how to address those problems, they proposed different solutions; a “plan”, a “guide,” and “strategies.” In other words, teachers wanted a plan-of-action when enacting inquiry-based discussions.

The teachers in this excerpt requested the exploration of different strategies that would help them teach as a solution to their problems. They wanted to know what they could do to engage the students. In lines 28 and 29 Ms. Kline mentioned equity concerns in the classroom, stating that she would like an increase in student engagement, rather than 3 or 4 students. An increase in student participation was also Ms. Ina’s concern. Her stated issue was not with the number of students involved, but in the way the students were involved. She wanted “effective” engagement, where students “build that information so that they come up with the answer.” The conversation introduced ideas of inclusion and knowledge construction.

From this excerpt, I framed the initial problem as needing a plan-of-action to effectively engage multiple students. The sought after solution was a set of strategies that could help students construct their knowledge. Locating the problem and solution in research-based strategies is similar to the social efficiency perspective of reflection (Zeichner & Tabachnick, 1991).The social efficiency perspective is based on education research that focuses on research-based strategies as the standard for teaching. Similarly, the academic reflective perspective (Zeichner & Tabachnick, 1991) views the teacher as the subject matter specialist and efficient at transforming the subject matter into comprehensible concepts for students. Based on the conversation, the teachers saw themselves as needing to help the students engage in learning the content through discussions, but did not know how to accomplish that goal. Their participation in university-based professional development implies that they were interested in what research could offer and add to their existing knowledge of science teaching.

Cultural Misunderstanding or a Cultural Mismatch?: "It's Not Like When I Was In School. It's Just the Culture."

As teachers read articles (see Appendix B for list of articles), the conversations changed to include student experiences outside of the classroom and their contributions to the classroom culture. In the following conversation, we read the article *Discursive Identity: Assimilation into the Culture of Science and Its Implications for Minority Students* by Bryan A. Brown (2004). The research article contributed to the conversation by showing that student ethnic cultures and experiences played a role in how students related to and participated in the

culture and language of science. Furthermore, the article discussed implications for curriculum development and instruction in learning environments where minority students are required to learn the culture of science.

Below is an excerpt from the second professional development workshop. Here, Ms. Lewis talked about a teaching experience in Kenya to demonstrate how student experiences (and language) add complexity to the enactment of scientific discussions. The excerpt shows a negative outcome because the teacher was uninformed and unaware of the students' ethnic cultural experiences.

Ms. Lewis: I tried to have discussions in the class, and they didn't tend to work very well in the class. The students weren't very receptive to them. And I hadn't been teaching long enough at the time that I was comfortable deviating from the things I knew how to do. And they expected me to just come and tell them and then leave. They were really uncomfortable anytime I tried to start any discussions, and I think I probably would have just, number one, I would have just stuck with it and forced the issue, but I didn't because I wasn't secure enough in my own skills, and I also, there were a lot of language issues. My Swahili was pretty solid, but many of students didn't even speak very good Swahili. And I didn't speak enough of the mother tongue to be able to make some of the transitions that… I would have realized now that it would have been better to pick up more of the Kitahila than the Kiswahili. I think that would have helped.

Ms. Ina: Where did you learn Swahili?

Ms. Lewis: I was in the peace-corps. I started studying Swahili before I went, and there is an intensive 3-month period of pretty intensive language training. And living with a local family, where I thought I was speaking Swahili but they were actually speaking Cucuyu. So, I was the special one in language class, because I would come in with new words I learned and take Cucuyu verbs and conjugate them in Swahili. And everyone

was like, “What are you trying to say?” “Well, it works at home.” “Ok, you’re the special one.”

…

Researcher: I have a friend in Kenya and she loves it. So, you didn’t get through the article, but, now seeing how they articulate it, what you had instinctively known, how would you translate that now into what you are doing?

Ms. Lewis: By trying a wider variety of strategies. Like I said, not giving up so quickly. Being willing to force things a little more than I was. Because at the time I was so worried about being culturally sensitive that I didn’t ask some of the questions that I could have. When in doubt, I figured it was better to not. Because I had the reputation of blundering into areas that was not ever talked about… was really good at clearing the staffroom when I asked a question. There was only one teacher who would say, “You know, you have got to learn.” “Well, I’m trying and if no one tells me, how am I going to know?” I got in trouble… I kicked up a big stink about my students. They would ask to go to the bathroom and they would be gone 30-40 minutes and it infuriated me, so I finally stopped letting them go. So, I talked to one of the teachers and she came and talked to me and said, “You know, you have got to let them go to the bathroom.” “I know how long it takes to go to the bathroom. The bathroom is right there, how can it take so long?” She’s like, “You know why it takes them so long? The reason it takes them so long is that many of them have been circumcised.” This was not even on my radar.

Researcher: The girls, you mean?

Ms. Lewis: Yeah. You know, there were a lot of things like that; I was just clueless. And she was, “Well, of course you know they have been done because it’s done to everyone; it has been done to you… I was like, “No, no, no.” She was like, “It has been done everywhere.”

Researcher: It’s interesting, those cultural things that happen in the town and in the neighborhoods that take a toll in the classroom that you don’t know about. It affects how the students interact and how you interact with them.

Conversations in professional development helped teachers understand the importance of being able to communicate in the language of the students. Ms. Lewis had a prior experience that shaped her statements about communicating with her students. In the conversation, she explained that while teaching in Kenya, she learned that her students had cultural experiences that prevented them from participating in their classroom activities in the way the she would have liked. She learned that her students were often missing from the classroom because of female circumcision (lines 42 and 43). In addition, since Ms. Lewis did not speak the language very well, she had trouble communicating and understanding what her students were experiencing. Ms. Lewis talked about not being comfortable with discussions because she was not familiar with the mother tongue (line 1 and 2). Because Ms. Lewis did not fully understand the students' personal lives, she was unable to connect with them in the classroom.

Although this initial conversation is not specific to the students in American classrooms, it made room for a conversation about understanding student experiences as a way to engage students in practices that may be different from familiar experiences. Ms. Lewis commented that she tried "a wider selection of strategies" (line 29), but she was still "culturally sensitive" (line 13) which prevented her from venturing into unknown territory. In the context of this conversation, "culturally sensitive" referred to her discomfort with the student's culture. Eventually, she talked with another teacher and learned about her students' cultural experiences and their mismatch to her's. The students were not deliberately misbehaving in class, nor did they lack the skills to participate in

class activities. Learning about those experiences enlightened her to underlying reasons behind her difficulty enacting classroom discussions.

From this conversation, I reframed the issue to include having cultural understanding. Another shift in conversation happened here (see Table 5-1). As teachers continued to look for a plan-of-action, the idea of learning about the students' cultural experiences was introduced. The teachers began to explore the idea that they misunderstood where the students came from, rather than believing that the students were unable to engage in rich discussions. Wade et al. (2008) describe the "teaching the culturally different" reflective perspective as understanding and learning about student backgrounds and cultures and adjusting the curriculum to promote multiculturalism. Ms. Lewis and Ms. Ina talked about student cultures, but not about changing the curriculum to meet cultural demands. The above excerpt demonstrates that Ms. Lewis was interested in understanding how culture helped shape student engagement in classroom activities, but did not mention how to adjust the curriculum to the students, as Wade et al. suggested.

The excerpt below was from professional development workshop #3, and this conversation revisited the article *Co-constructing Inquiry-Based Science with Teachers: Essential Research for Lasting Reform* by Keys & Bryan (2001). Earlier in the conversation (not shown in transcript), Ms. Ina said that she hoped to learn how to teach through inquiry-based methods from reading this article (see Chapter 4). As we discussed the article, she began to talk about the lack of progress of inquiry-based discussions in her classroom.

Ms. Ina: Last time was good. It's been really difficult.

Researcher: What's difficult.

Ms. Ina: They just do anything. I've been thinking that the 10th graders are really immature. I have 10th graders in chemistry that it may work with. I just think they are immature and have given up.

Researcher: Is there something you can do to help with that?

Ms. Ina: Like I said, more labs. It seems like we need to be doing something. Also, about the generation gap, they are used to things being popped at them all the time. It's not like when I was in school. You just knew you had to put time into something. They just, in chemistry, if they're not getting the right equations, they don't even try. If it doesn't pop up right away, then, "I don't get it." And they just move on. I just think it's a generation thing. I don't know the answer to that. Also, with the research… "I'm not finding the answer." This is research; if you don't find it, then search somewhere else. It's just the culture.

Similar to Ms. Lewis, Ms. Ina related the implications of the article to her classroom experience. In Chapter 4, I described skepticism from Ms. Lewis and Ms. Ina in regards to the research articles. In those conversations, Ms. Ina expressed that research-based curriculum developers were unaware of the experiences of students in urban schools, and that inquiry-based curriculum materials developed in research-based institutions were ineffective in her classroom. In the excerpt above, Ms. Ina elaborated on this idea. She commented that the students came from a different leaning perspective and culture than she did, and that the curriculum the students used did not relate to their learning cultures. She talked about her learning experience as being focused on work ethic, something that her students lacked (lines 11-14). Ms. Ina

used words and phrases like “immature”, “they don’t even try”, “given up”, and “It’s just the culture” to describe her students. From these phrases, Ms. Ina described a problem; her students had a learning culture less efficient than hers. This conversation resembled the reflection perspective “remediating cultural deficiencies.” In her descriptions, she used negative characterizations of her students, suggesting that her students’ learning culture was inadequate and did not provide the students with the necessary tools to succeed in school, like “putting time into something” (line 13). Rather, the students’ culture just “popped (things) at them all the time.” She suggested a solution- more hands-on activities should be incorporated into the curriculum, like labs. In line 11, she said, “Like I said, more labs. Its like we need to be doing something.”

This conversation suggests that there was a shift in the way the teachers talked about issues with teaching. Originally, the teachers talked about lacking appropriate strategies to engage students in inquiry-based discussions. In a previous conversation about the Brown (2004) article, Ms. Lewis talked about having an understanding of student culture in order to teach effectively. During this conversation, Ms. Ina identified a cultural mismatch. The mismatch positioned the students as unwilling to learn without doing something hands-on. According to Wade et al. (2009), remediating cultural deficiencies argues that when students struggle in school, it is due to a cultural issue; aspects of the students’ culture are preventing them from being able to learn and interact productively in school. However, the teacher takes responsibility in “repairing” the student.

Similarly, the developmentalist reflective perspective (Zeichner and Tabachnick, 1991) argues that the teacher takes time to understand the students' developmental process and progress, and incorporates that into instruction. During the conversation, Ms. Ina pointed to the students' lack of cultural work ethic and related it to the students' maturity level. She accepted the responsibility to learn about the students in order to ameliorate the problem by attending professional development workshops to understand student learning, develop her pedagogical content knowledge, and deepen her understanding of engaging students through inquiry-based teaching methods, rather than moving them to a remedial science class. She suggested the inclusion of additional hand-on activities because they "need to be doing something," but later admitted that she did not know what they answer was (line 16) due to generational differences. Ms. Ina recognized that something additional to "doing more labs" needed to be done and that there was a complexity that she could not articulate or comprehend. She did not know what the next step was, but realized that the problem was more complex than employing a strategy, as she articulated student "culture" as part of the problem.

As before, the research article provided an opportunity to confront skepticism and think about specific instructional problems. In this excerpt, Ms. Ina continued to express her struggle to find a plan-of-action, saying in line 5, "They just do anything," and attributed this problem to being "really immature" and having "given up" (line 6 and 7). In relation to Ms. Ina's uncertainty about the validity of science curriculum development in urban schools, she expressed

concern with the students' culture and experience. She had difficulty reconciling differences between the students, the curriculum, and herself. Earlier, the teachers said that inquiry was hard and that they needed strategies for enactment. Now, the problem was re-specified to needing a plan-of-action that takes into account the mismatch between the teacher and student cultures. Although her solution to the problem did not change, she realized that there was something missing, but was unable to identify it (line 16).

Ms. Ina did not believe that her students were deficient. Her instructional problem was that she did not know what to do with what she perceived as cultural differences. In an interview with Ms. Ina, she expressed that her students had "information inside of them," and that she wanted them to recognize and access it.

Researcher: In our planning sessions, we decided that certain discussion practices match our criteria for meaningful discussions. Why do you find those practices important?

Ms. Ina: I want them (students) to understand that they have a lot of information inside of them already. And I hope that by doing all of this, in other classes, they will be able to not just sit there and let somebody else come up with the answers or comments. But that this will condition them to be able to stand on their feet and speak out. It's just something that I think is really difficult to do, because many of my students have been conditioned to doing hand-outs and worksheets. And I think today, when I shut the lesson down, and gave them bookwork; that's when they are the most quiet. That's when they are most engaged and focused. That doesn't mean… in fact, I don't think they are learning when they do that. But they have been conditioned into schooling that looks that way. And I think that is sad.

Supporting students' learning of inquiry-based communication and thinking was significantly different from the way they typically learned, and Ms. Ina argued that re-teaching them to learn by constructing knowledge for themselves was difficult. In the excerpt above, Ms. Ina commented that she wanted her students to learn how to speak for themselves, stating that she did not want them to "sit there and let somebody else come up with the answers or comments" (lines 7-8) for them, but instead be able to "stand on their feet and speak out" (line 8). She also recognized that reconciling student, curricular and teacher experiences to accomplish inquiry goals was difficult (lines 9-10).

Ms. Ina and Ms. Lewis used the research articles to talk in detail about how student culture and experiences can shape the way discussions are enacted and taken up by the students. Ms. Ina continued to express doubt in her students' willingness to successfully engage in inquiry-based activities, but was eager to learn how to overcome cultural tensions between the students, the curriculum, and herself, as she tried to achieve her discussion goals. Ms. Lewis recognized that an understanding of students' cultures could help her select and enact strategies in ways that related with the students, which could help her get closer to her instructional goals. Both teachers wrestled with a new question: How does culture play a role in teaching through inquiry?

Social and Institutional Barriers Create Instructional Difficulties: "They Are Just Allowed to Wander and There Is No Control."

Reading research articles continued to help the teachers talk about how student experiences affected their experiences in the classroom. The next excerpt from professional development workshop #4 demonstrates a shift in

conversation similar to professional development #3. Rather than talking about student culture, they talked about student experiences within the school system and how those experiences contributed to student participation and engagement in classroom activities. In this case, we previously read the article *Bringing the Background to the Foreground: What Do Classroom Environments That Support Authentic Discussions Look Like?* by Xenia Hadjioannou (2007). The article discussed features of a 5th grade classroom's learning-environment, where "authentic discussions" (Hadjoannou, 2007, 371) were frequent.

Ms. Lewis: I think it [the article] just reinforced what I took the first time. I think I knew my students pretty well, but I have been trying to have more mini-discussions with them. In the Xenia article, one of the things they talked about was experiences her students have had. I try to do that more. It makes the students feel more special. I am all for making your students feel good. I don't know if it has helped the discussion per se, but it has added to the atmosphere of the classroom.

Researcher: I think that's important. If students don't feel that their contributions are interesting, then it's hard to add to the discussion.

Ms. Lewis: I think I don't really have a problem with the atmosphere in my class, but a lot of them, the classes they have before are stressed, and making them feel special before anything has really happened to help them get over whatever they are breaking in.

Ms. Ina: What do you think has happened in the other class?

Ms. Lewis: Most of my students have a math class just around the corner from my classroom. The teacher's is a screamer.

Researcher: I hear them talking about her.

Ms. Lewis: In first hour, I hear her screaming at them. I know when they have had a bad morning in their math class. She is interesting. Then a lot of them go from that math class to the English class. That English teacher is nuts, and frustrating to deal with. She isn't mean, but she's really disorganized and they want structure and they don't get it there. So, they go from being screamed at to this lack of structure, not all of them, but a lot of them. So they come in a little frazzled. The first part of my class is calming them down. And half of my class has a special math class and they are coming in with a different mind-set. They adore their teacher and have been working really hard for 2 straight hours. The halves of the class sometimes are in opposition with each other. You kind of have to bring them back together as a class. Many of them have been together since elementary, so I think it helps.

Researcher: I would never have guessed that they have gone through so much frazzle throughout the day. They always seem pretty… doing the work and on task.

Ms. Lewis: Most of them…

Ms. Ina: I think it's insightful that you consider those things.

Ms. Lewis: I didn't used to. It used to be all about me.

Ms. Ina: Oh… because I never think about that. I know that I have one student whose grades have dropped drastically and I don't know what's going on. I had called his home and couldn't get a hold of anyone. I got nowhere. It got from an A to an E. Everything I said to him; he would just get a nasty attitude. So, I kept yelling. Then I realized that's not working at all. So I stopped yelling at him and used a calmer voice. And now he is passing, and I don't know what happened, but something happened. But you are considering the whole class.

In Ms. Lewis' explanation of student experiences, she made relevant the events in the students' lives that are not necessarily related to her class. In lines 3 and 4, Ms. Lewis talked about how the articles encouraged her to try to take into account students experiences more often and that it was something that she

was going to try to do in her own classes as well. She talked about helping the students feel “special” in order to create a positive atmosphere in her classroom, and hopefully contribute to the discussions.

Ms. Lewis acknowledged that the students’ previous experiences in school were stressful (line 12) and that when they came to her class, they had been “frazzled” (line 27). She explained that she could hear her students being yelled at in the previous hour and that the students often had bad mornings in other classes. She went on to explain that the students also had a class that was disorganized and lacked structure. She commented that the students, “go from being screamed at, to this lack of structure… so they come in a little frazzled” (line 26-27). She finished her explanation by saying that “the first part of [her] class is calming them down.” She recognized that in order for her students to develop the behaviors that she would like to see (inquiry-based), she had to acknowledge the students’ experiences before she even began to teach. During the conversation, Ms. Lewis suggested “making them feel special before anything has really happened to help them get over whatever they are breaking in” (lines 12 and 13), “calming them [the students] down” (line 27), and “bring them [the students] back together as a class” (line 30 and 31) as a contribution to the establishment of structure and organization in the classroom.

During this conversation, Ms. Ina expressed interest in this suggestion and potential solution. She responded to Ms. Lewis’ explanations and said that she thought Ms. Lewis was “insightful” for considering her students previous experiences and how they contributed to their performance in class and admitted

that it was something she never thought about (line 44). In her following story, she explained that she considered one student and how his prior experiences might have had an affect on his classroom performance, but stated that she did not think about the class collectively. She said that she “kept yelling” at him (line 47), but later realized that talking to him in a calmer voice (line 48) was more effective. This is similar to Ms. Lewis explaining that she had to calm her students down in order to get them in the right mind-set for class.

This excerpt demonstrates another change in the way the teachers talked about teaching. Wade et al. (2008) explained that when the teacher learns about the students’ backgrounds and experiences and adjusts the curriculum to match them as a way to promote multiculturalism, they are reflecting according to the human relations perspective. Teachers suggest solutions to problems that incorporate intergroup skills, acceptance, and friendship. As Ms. Ina and Ms. Lewis continued to read research articles, their conversations shifted to focus on student experiences and cultures. Ms. Lewis talked about “bringing the students back together” and “making them feel special”, and Ms. Ina mentioned, “talking in a calmer voice”, which is consistent with encouraging friendship and acceptance, although they did not talk about promoting multiculturalism through curriculum alterations.

Through consistent discussion about research articles, reflection helped the teachers locate their teaching difficulties in social barriers that they faced and the students faced, rather than student inabilities. The excerpt below is from professional development workshop #4 with Ms. Lewis and Ms. Ina. In this

excerpt, Ms. Ina described negative comments that discouraged her from teaching and the students from learning. During this professional development segment, Ms. Ina added a different angle to the problem. Not only were there misunderstandings or mismatches between the teachers' and students' experiences, but also, neither teacher was being supported by their school community to learn about their students' cultures and experiences. Both teachers and students constantly fought against negative perceptions and expectations from their school and neighborhood communities.

Researcher: How do you take into account these outside happenings into how you do things in the classroom? You said you didn't think about it before [to Ms. Ina].

Ms. Ina: About how they are being affected elsewhere and how they are coming into the classrooms. I do think the halls affect it, they are just allowed to wander and there is no control. They can get to class late and it doesn't matter, there aren't any consequences. And it's difficult to teach like that. Sometimes I am just so discouraged, but I look and know that there is one that I can reach, and I do it for this one, if that's all I have. Other than that… I also have to think about, there are so many things lacking in the system that I have to compensate by being the best teacher for them. I have other teachers that say why do you bother? Why do you do that? Like for instance, why do I come here [to professional development]? It's a waste of my time because nobody cares and its just, you get it from all angles. And when I am out in the community, and I tell them where I teach, they are really surprised. Do I feel safe and they hear the bad things, but not the positive things. And I think that, I don't know what that is. I think in all white schools, terrible things happen, but people don't make a big deal about it.

Ms. Ina made a connection between her teaching and the support that she received from her educational institution and community. She explained that teaching was difficult because her school provided no support, yet discouraged

her from making efforts to seek outside supports, like professional development. In the above excerpt, Ms. Ina explained that her teaching community intensified negative views of her students and considered professional development as a waste of time (lines 11-14). Consequently, the teachers and students both attended class with negative perceptions of themselves and of each other. Because their perceptions of each other clashed, miscommunication occurred and Ms. Ina became discouraged.

She also described the lack of support the students received from their school, as “they are just allowed to wander” (line 5), “there is no control” (line 5-6), and “there aren’t any consequences” (line 6). Here, I highlight a lack of support as a large-scale issue. In this excerpt, Ms. Ina commented on the lack of institutional support for students and teachers, and its contribution to instructional difficulties.

Ms. Ina also talked about how other teachers and members of the community made discouraging comments. Other teachers said, “why do you bother?” (line 11), “why do you come here [to professional development]?” (line 11-12), and “it’s a waste of time” (line 12). In addition, people in the community asked her if she felt safe in her school, and pointed to the negative characteristics of her school (lines 13-15). Ms. Ina said that when she “gets it from all angles,” she felt discouraged.

Reading and discussing research articles created opportunities for the teachers to talk about social barriers that made teaching difficult. This excerpt demonstrates a change in how the teachers talked about the problem. Over time,

the problem evolved to recognize a lack of support on an institutional level. Although we did not find a solution to social barriers, we talked about making students feel accepted and creating a sense of community in the classroom as their enactment pushed towards their discussion goals.

Summary

The results in this chapter show that professional development can provide teachers with opportunities to have reflection changes about teaching inquiry-based discussions in their classroom. Through the process of framing problems and brainstorming solutions, teachers demonstrated a shift in how they talked about their instructional problems and solutions (see Table 5-1). Teacher conversations in professional development showed similarities to different types of reflection, indicating that the use of research articles has the potential to support and promote a change in reflective perspectives on teaching, and thereby facilitate changes in how teachers intend to approach teaching.

Change in Teacher Talk	Using Strategies to Promote Inclusion and Knowledge Construction	Cultural misunderstanding or cultural mismatch	Social and institutional barriers create instructional difficulties
Problem	Inquiry is difficult to teach.	Is inquiry difficult because the student culture is unable? Or, is inquiry hard because I do not understand the students?	Is inquiry difficult because students have negative school experiences that carry into the classroom? There is lack of support on an institutional level.
Solution	Need a plan-of-action; a collection of strategies	Need a plan-of-action that takes into account student cultures.	Make students feel special and accepted to create a comfortable community in the classroom

Table 5-1: Changes in Teacher Talk During Professional Development

Initial attempts to learn about enacting inquiry-based discussions in the science classroom involved teacher conversations during professional development that focused on acquiring strategies that could increase student participation and promote knowledge construction. During this conversation, the teachers talked about the issue of needing a plan-of-action to effectively engage multiple students. When teachers began to read the research articles, the conversations changed to include student cultural experiences outside of the classroom and how they contributed to the classroom culture. The teachers talked about cultural experiences as being a mismatch and struggled to understand how to reconcile the science curriculum, and student and teacher culture. Finally, reading and discussing research articles created opportunities for the teachers to talk about social barriers that made teaching and learning difficult.

Over time, the problem evolved to recognize a lack of support on an institutional level.

CHAPTER 6

CONNECTING CLASSROOM ENACTMENT TO REFLECTION: AN ANALYSIS OF CHANGES IN TEACHER INSTRUCTION

Overview of Chapter

The research question guiding this analysis is: *How do teachers' enactment of inquiry-based discussions demonstrate their reflection practices, as shown in the collaborative professional development workshops?* This part of my study is an analysis of teacher classroom enactment, and its demonstration of changes in professional development conversations among the teachers. I show that teacher conversations during professional development can inform their instruction. In this chapter, I intentionally focused on instructional accomplishments and progress and their relation to professional development.

In Chapter 4, I showed that professional development could give teachers opportunities for reflection on practice, by unpacking different aspects of teacher conversations, and highlighting the conditions, such as resources, that helped encourage reflection. I also showed that through conversations, teachers expressed several instructional goals for themselves in the enactment of inquiry-based discussions. In Chapter 5, I showed that as teachers talked about their instruction, teacher conversations changed, showing similarities to different

reflective perspectives (Wade, et al., 2008; Zeichner & Tabachnick, 1991). The teachers' conversations started with an articulation of needing a plan-of-action when teaching through inquiry-based methods and that a potential solution was the acquisition of teaching strategies. Over time, teacher conversations included social barriers as part of their instructional issues and solutions. Social barriers included the lack of school and community support, making it difficult for teachers to provide students with rich learning opportunities. Although a potential enactment solution to this problem was not suggested, the general consensus was to promote a positive atmosphere in the classroom, by making the students feel "special" and appreciating the progress that students made, in spite of the negative social obstructions they encountered in their schools and neighborhoods.

Through professional development participation and conversations, the teachers not only established goals and potential changes to instruction, but they also talked about changing their approach to teaching as a way to achieve their instructional goals. In this chapter, I show that although both teachers set challenging instructional goals for themselves in professional development, they were met with constraints that, in many cases, hindered their progress during enactment. I show that although professional development can provide teachers with opportunities to analyze their teaching, establish future enactment plans, and talk about changing their instructional approaches, the conditions surrounding their classrooms, and the teachers' initial view of their teaching and students, also plays an important role in how enactment occurs. Both teachers in

this study were challenged by similar difficult institutional constraints (see tables 6-2 and 6-3). However, each teacher differed in how they viewed themselves as teachers and how they viewed their students. These differences contributed to the consistency, or lack of consistency, between professional development conversations and reflection about enacting discussions, and the actual enactment of discussions (see Table 6-4).

First, I describe how discussions were presented to the teachers and how they were modified during professional development workshops. I explain each type of discussion, how they were supported in the curriculum materials, and provide a sample support from the teaching guide we created in professional development. The supports created in professional development were a product of professional development conversations and contributed to the teachers' real-time teaching decisions.

Next, I show how Ms. Lewis's enactment showed similarities and differences to her expressed goals in professional development. She struggled to balance her lack of trust for research in urban schools and the negative school conditions she and her students faced with her willingness to risk changing already established classroom norms to inquiry-based norms that have the potential to fail. In addition, she described a positive view of her students in a functional classroom, and that changing the classroom structure to something unfamiliar and untrustworthy was uncomfortable. As a result, Ms. Lewis preserved her original classroom structure, while experimenting with low-risk discussion practices. Her decision to make small changes, regardless of the

goals expressed in professional development, seemed to come from her fear of losing control of her classroom to something that she did not completely trust. Although the changes she made in her classroom may appear to have been small, when you take into account the constraints she worked within and her initial distrust for research-based methods of discussion, these changes are quite significant for her.

Finally, I show that Ms. Ina also attempted to enact inquiry-based discussions in her classroom, but struggled to balance the negativity from her school community with her success and progress with inquiry-based teaching methods. In addition, I show that although Ms. Ina struggled to balance the expectations of traditional didactic instruction and the demands of inquiry-based teaching and learning, she experimented with high-risk discussions and practices. In Chapters 4 and 5, Ms. Ina expressed her goal to transfer control of discussions to the students by allowing them to take ownership of the discussions and construct their own knowledge of science. Ms. Ina employed particular strategies that would increase student expression of individual ideas and promote student interaction, making her enactment consistent with her professional development goals. During her enactment, she was persistent in encouraging students to participate in discussions, but was met with constraints from other sources.

Representing Discussions to Teachers

Using educational research to understand the process and characteristics of rich, open-ended discussions, I created written supports for the teachers to work with and modify in professional development. The curriculum materials

included descriptions of 3 discussions types promoted in the curriculum: reviewing discussions, generating discussions, and problem solving discussions (see Table 7). Using AAAS criteria (see Appendix A), the teachers and I co-constructructed specific goals for each discussion. Reviewing discussions involve putting ideas together, or assembling multiple activities into a coherent whole. This encourages students to make connections to personal experiences, to the driving question, to the previous or the following lesson, or to knowledge gained in other units, lessons, or subject areas. This type of discussion helps the teachers and students hear what other students are thinking. During a reviewing discussion, students develop an understanding of scientific language by incorporating it in their responses, demonstrate their use of knowledge on a subject, and think about phenomena and experiences related to the discussion topic.

Generating discussions encourage students to brainstorm ideas and prior knowledge. Using the AAAS criteria, we aimed to help students understand the discussion purposes, take into account student ideas and prior knowledge, and promote student thinking about phenomena and their experiences. This type of discussion helps students make comparisons between other student ideas and think about how the ideas relate to the discussion topic.

Finally, problem-solving discussions may involve challenging other students, debates, or argumentation in which students are encouraged to justify their ideas with evidence. This type of discussion may involve the revision of previous ideas as students learn new information that calls into question the

limitations of what they “knew” previously. Additional goals of this discussion include developing and using scientific language, demonstrating understanding of content through evidence, and also promoting student thinking about phenomena and their experiences.

Discussion Type	Description of Discussion Type
Generating	Brainstorming ideas and assessing prior knowledge.
Reviewing	Putting ideas together or assembling multiple activities into a coherent whole.
Problem-solving	Challenging other students, debating, and/or argumentation. The use of evidence is stressed.

Table 6-1: Summary of Discussion Types

After delineating the discussions and determining instructional goals, I grouped specific strategies under each discussion type to help teachers during discussion enactment. I used research-based discussion practices to guide my organization of the supports (see Chapter 2). I also applied Davis and Krajcik (2005) design heuristics for educative curriculum materials in the presentation of the discussion supports; provided a rationale and enactment strategies.

Below is an example of how discussions were supported in the curriculum materials. Every discussion in the unit is supported in the same way; meaning, each discussion has a rationale, suggested strategies, questions, and prompts to help guide the discussion. The left column is a description of the written curricular

text. The right column provides an explanation of and rationale for the provided written support. These supports were consistently provided throughout the duration of the unit and did not decrease or fade over time (Puntambekar, 2005). In the example, the problem-solving discussion below was intended to help students understand the relationship between DNA, genes and heredity. This discussion followed an activity that analyzed a hemoglobin DNA sequence and explored protein structure and function after a genetic mutation. Students were to use the activity as supporting evidence during the discussion.

Problem Solving discussion - What is a genetic disease?	**Teacher Support Description**
Discussion Rationale: Students should realize that since genes are contained in DNA, that DNA is what is passed on from generation to generation—this therefore means that mutations can be passed on from one generation to another. In this discussion, students go beyond surface answers. They make sense out of information.	To help the teacher understand the subject matter goals of the discussion and the intellectual and interactional skills students can develop during the discussion.
Suggested Strategies:	**To provide the teacher guidance while teaching in the moment.**
Think/Pair/Share: You can have the students first try it on their neighbor, then reconvene as a class and share their explanations.	To encourage student-student interactions on a smaller scale. This strategy can help students gather their ideas and thoughts in preparation for a whole class discussion.
When students give answers, here are some things you can do: *Encourage students to use complete sentences.*	Teacher moves to give teachers options for encouraging student participation.
Make Knowledge Explicit: Evidence: What evidence did they use to explain their answers?	A science specific strategy. It helps students recognize how evidence provides support for a given idea. It also provides an opportunity for the student

	expressing the idea to support, further develop, or challenge the idea they are proposing.
Addressing Other Students: **Student Centered:** Encourage the STUDENTS to initiate the discussion questions, follow-up questions, challenging of evidence, etc. Try to GUIDE the discussion rather than lead the discussion. Ask students to consider a previous response while formulating their own. For example: Teacher: "John, what do you think about what Suzie just said?" John: "Suzie said that protein shape would stay the same. I disagree. I think that if amino acids change, then the protein shape changes too."	To place the cognitive responsibility on the students. Teacher moves to encourage student-student interactions.
Encourage students to ask other students questions about their predictions and similarities and differences. For example: Teacher: "Suzie, do you have any questions about John's explanation?" Suzie: "Yes, why do you think that this disease can be passed to offspring?	Teacher moves to encourage student-student interactions.
Follow-up Questions: Use follow-up questions, such as "WHY" and "HOW DO YOU KNOW THAT" when students give answers (claims). This can push them to think deeper about why they think they know something. *Additional follow-up questions include:* • How does X compare with Y? • How can . . .? How might . . . ? • How do you know? What evidence supports that idea? • What does it mean to say …? • Why doesn't our old model work to explain this new phenomenon? • Why can't …?	Teacher moves to promote students elaboration of responses. This provides teachers with probing questions.

• How could we figure this out? • What new questions do you have?	
Reflective Toss: Rather than evaluating the students response or question, ask another question that will encourage them to think about what was said. For example: Suzie, “How come DNA is passed to the offspring.” Teacher, “Why do YOU think DNA is passed to the offspring?”	To place the cognitive responsibility on the student and promote student elaboration of ideas.
Supporting Communication	
Public Documents: On the board, create a public document of what the students say, so that everyone can keep track of what has been said. You can ask a student to do this. This will encourage the students to listen to one another and use other responses to reflect on their own responses. *Here are some points/questions to guide you:*	Allow students to get a sense of how their ideas and data compares to everyone else’s, and to address differing ideas and data. Agreeing on the record means that students have common ground to talk about and point to when they move on to the next phases of the discussion.
• Ask students if they have ever heard of the word “genetic” or have they every heard a disease be called genetic. Ask students what they think that means?	Conceptual ideas for students to address during the discussion. Teacher prompts to help initiate the discussion.
• Students should realize this genetic disease must involve genes and perhaps mutations that cause disease. • Ask students, if genes are passed on from parents to children what does that mean about DNA and the types of mutations modeled earlier in the lesson? Does some who has sickle cell disease have a parent with the mutation?	

Although the strategies provided above were designed to correlate with research-based discussion practices, this original layout was scattered and

difficult for teachers to use during enactment. While participating in professional development, the teachers and I collaboratively revised and reconstructed the supports into a guide that the teachers described as “easy to read”, “easy to scan before the start of the discussion,” and giving the teacher the freedom to “carry it around with them while having a discussion.” After several iterations of the supports, we created a discussion guide in a table format. Below is a description of the supports. Although the written supports were in table format, I will represent them in prose form here.

Generating Discussion

Supporting Communication

Rationale: Make a Public Document: On the board, keep track of student responses with a public document to encourage listening and reflection.

Strategies: Use a chart on the chalk board or dry-erase board; Use a chart on an overhead projector; Have a student lead the discussion by creating a chart on the board; Have each student come up and write their individual ideas on the board.

Think/ Pair/ Share

Rationale: Helps the individual student before they have to talk in a group.
Students practice on a partner/in a group before addressing the class.

Strategies: Provide students with the questions that you will use in the larger discussion as guidelines for their small group discussion.

Pre-reading activity/ Brainstorming

Rationale: To help students start to think about what they will be learning. To help student understand their prior knowledge and understanding about a topic. To relate the activity/reading to the student.

Strategies: *Connect this to the public document made:* Why are we doing this?; What do you think is going to happen when… ?; What do you think it means to… ?; Do you know anyone that…?

Follow-Up Questions

Rationale: Follow-up questions help push the students’ understanding. They are meant to help them think deeper about why they think they know something. Connect them to the public document. Make connections back to the driving question.

Strategies: What have you observed or experienced?; What else is on your group’s list?; What do you/other people think about when they hear the word ___?; Who has a different idea/response/way of thinking about this?; What do you know about [topic X]?

Student Interactions

Rationale: It is important for students to learn how to communicate in science; vocabulary and behaviors.

Strategies: *Student Centered:* Encourage STUDENT discussion initiation of questions and follow-up questions. Try to GUIDE the discussion rather than lead the discussion; *Addressing Other*

Students: Encourage students to address each other and ask each other questions. Ask students to consider a previous response while formulating their own.

Reviewing Discussion

Supporting Communication

Rationale: Make a Public Document: On the board, keep track of student responses with a public document to encourage listening and reflection.

Strategies: Use a chart on the chalk board or dry-erase board; Use a chart on an overhead projector; Have a student lead the discussion by creating a chart on the board; Have each student come up and write their individual ideas on the board.

Follow-Up Questions

Rationale: Follow-up questions help push the students' understanding. They are meant to help them think deeper about why they think they know something.

Strategies: What have you observed or experienced?; What else is on your group's list?; What do you/other people think about when they hear the word ___?; Who has a different idea/response/way of thinking about this?; What do you know about [topic X]?

Student Interactions

Rationale: It is important for students to learn how to communicate in science; vocabulary and behaviors.

Strategies: *Student Centered:* Encourage STUDENT discussion initiation of questions and follow-up questions. Try to GUIDE the discussion rather than lead the discussion; *Addressing Other Students:* Encourage students to address each other and ask each other questions. Ask students to consider a previous response while formulating their own.

Problem-Solving Discussion

Supporting Communication

Rationale: Make a Public Document: On the board, keep track of student responses with a public document to encourage listening and reflection.

Strategies: Use a chart on the chalk board or dry-erase board; Use a chart on an overhead projector; Have a student lead the discussion by creating a chart on the board; Have each student come up and write their individual ideas on the board.

Use of Evidence

Rationale: To help students make their knowledge known to the class and themselves. Can use the activity, the readings, or other resources.

Strategies: *Evidence:* What evidence do student use to explain their answers?; What do we know so far?; What do we want to formulate from what we know? *Predictions:* What would happen if __ changed?

Follow-Up Questions

Rationale: Follow-up questions help push the students' understanding. They are meant to help them think deeper about why they think they know something. Connect them to the public document. Make connections back to the driving question.

Strategies: What have you observed or experienced?; What else is on your group's list?; What do you/other people think about when they hear the word ___?; Who has a different idea/response/way of thinking about this?; What do you know about [topic X]?

Student Interactions

Rationale: It is important for students to learn how to communicate in science; vocabulary and behaviors.

Strategies: *Student Centered:* Encourage STUDENT discussion initiation of questions and follow-up questions. Try to GUIDE the discussion rather than lead the discussion; *Addressing Other*

Students: Encourage students to address each other and ask each other questions. Ask students to consider a previous response while formulating their own.

Recognizing a Discussion

Since each teacher enacted suggested discussions using the supports developed during professional development, I used the discussion supports as criteria while I observed teacher enactment of discussions. In my observations, I 1) used the curriculum suggested discussions to document the occurrence of a discussion, 2) determined whether the discussions were consistent with descriptions from professional development conversations and goals, and 3) documented whether a teacher enacted a discussion that was not suggested in the curriculum. For example, both teachers expressed on several occasions that the public document was a strategy that they used in every discussion. If a teacher or student created a public document, I documented it as a discussion.

MS. LEWIS

Tensions Between Professional Development Goals and Real-Time Enactment

The initial conversation at the first professional development workshop gave the teachers a chance to articulate instructional issues they faced when enacting inquiry-based discussions. Ms. Kline stated that although inquiry-based methods were expected of them, she did not know how to achieve inquiry-based instruction in the classroom. Ms. Lewis and Ms. Ina continued this conversation in later professional development workshops, and highlighted specific problems that made inquiry difficult.

Through professional development discussions, Ms. Lewis and Ms. Ina demonstrated changes in conversation and talked about how to adjust instruction to match their new thought processes. Ms. Lewis seemed to face a tension between accomplishing professional development goals that required changes in classroom norms and upsetting previously established norms (see Table 6-2). There seemed to be high risk in changing instruction for Ms. Lewis; she may not have wanted to perpetuate inadequate reports of their students through this study of their discussion engagement, nor did she want to add stress to the students by drastically changing the norms of the classroom. This tension may have made her uncomfortable, and she seemed to alter instruction in a way that maintained previously established norms, but embedded strategies that were different from what she and the students normally did.

Ms. Lewis consistently said that she wanted to try new things in the classroom; the opportunity to experiment with different strategies and discussion

types that she could use with a variety of students. She seemed to be successful in two ways; 1) she experimented with different discussion types, when she initially doubted them in science classrooms, and 2) she experimented with new strategies, like the public document, when she initially thought that they would cause discomfort among the students.

Inquiry				
Ms. Lewis's Tensions	Lack of support: Student Culture	Distrust for Research-based Methods	Changing Classroom Norms (i.e. lack of time)	Perpetuating Negative Stereotypes
Teaching Approach	Establish structure and maintain comfort in the classroom	Experiment with low-risk discussions and strategies	Experiment with low-risk discussions and strategies (i.e. ascending discussions, public document, including multiple students in discussions)	Experiment with low-risk discussions and strategies

Table 6-2: Ms. Lewis's Tensions While Enacting Inquiry-Based Discussions

Comparing professional development conversations with Ms. Lewis's enactment revealed that she wanted to try "new things" in the classroom, but found many of them "scary." This fear may have resulted in her alteration of inquiry; enacting discussions on her own terms. She maintained previously established classroom comfort and structure, but experimented with strategies within the comfortable context, as a way to prevent a disturbance in the classroom, in the event that the new strategies "did not work." However, Ms.

Lewis demonstrated instructional change when she chose to enact different types of discussions. She went from doubting the research and what they could tell her about discussions, to asking questions about her own practice and actually trying some of the discussions from the articles. Additionally, she went from thinking that her students would be jealous with the use of a public document to having a student create one in front of the class during a discussion. Even though she may have limited herself and the students to discussions and strategies that were familiar and comfortable, she tried them. She changed her normal instruction to experiment with discussions and strategies that she did not initially trust.

In the following section, I will show how Ms. Lewis described maintaining classroom characteristics of structure and comfort. I will then show why Ms. Lewis chose to maintain familiar classroom norms, despite her expressed goals during professional development. Finally, I will show an example of Ms. Lewis enacting a discussion, and highlight practices that achieved some of her professional development goals.

Minimizing Risk While Promoting Inquiry-Based Discussions: Ms. Lewis's Sense of Structure and Comfort

Ms. Lewis seemed to face a tension between accomplishing professional development goals that required changes in classroom norms and upsetting previously established norms. In order for inquiry-based discussions to be successful, new norms must be established in the classroom (NRC, 2000), and such changes may potentially upset prior classroom structure (Krajcik, et al., 2000). The concept of structure and comfort seemed important to Ms. Lewis. She

often talked about making instructional changes during professional development, but did not change the overall structure of her classroom, for fear of making the students uncomfortable. Throughout the professional development workshops, Ms. Lewis continued to narrow her description of “structure.” She talked about her need to “stay on track” of the discussion, “know the purpose” of the discussion, and “not feel stymied when the direction of the discussion is off.”

From these descriptions, it appeared as though structure was an awareness and ability to *control* the purpose, sequence, and progression, in terms of content, of a discussion. For Ms. Lewis, structure came on two levels; 1) the type of discussions she enacted and, 2) the strategies she used that allowed her to confine the discussion within boundaries of familiar content and sequence. On the first level Ms. Lewis stated that she did not enact discussions that were too open-ended for fear of the unknown. On the second level, she wanted strategies that would prevent the students from venturing into areas that she could not predict or control, both in content and in student interactions. She limited changes in instruction to practices that were familiar to her students and herself.

Ms. Lewis also talked about structure providing a comfortable learning environment for herself and for her students. According to Ms. Lewis’s statements during professional development and interviews, comfort also came in two forms. First, student comfort was the affective reaction students had to the discussion. Ms. Lewis wanted students to have positive emotional discussion experiences; promoting familiarity and a non-threatening learning environment.

To achieve a positive emotional experience, she remained within the boundaries of certain discussion types and her use of specific strategies. Second, as the teacher, Ms. Lewis wanted to feel comfortable with, or knowledgeable of, the content she and the students discussed.

Experimenting With Discussions While Maintaining Comfort: Adhering to Reviewing and Generating Discussions

Ms. Lewis continued to argue for enacting specific low-risk discussions in the classroom. However, her willingness to experiment with these discussions demonstrated a change in instruction. In Chapter 4, I showed transcripts of Ms. Lewis expressing doubt in education research. Recall her statement,

> The thing is we look at this and know these numbers are not accurate, no one is saying to the public that the numbers are wrong, and what I am finding to be true is that people hurt by the study are saying that the numbers aren't right. But people have this image of Detroit. It's just bad.

I explained that Ms. Lewis and Ms. Ina were disappointed and frustrated with how education research depicted them. I also explained that Ms. Lewis and Ms. Ina argued that education research was misinformed, lacked understanding of urban school culture, and did not work in the classroom, resulting in their lack of trust for research. Later, Ms. Lewis expressed her doubt in research in science discussions. During professional development, she said,

> What I expected them to say is what a discussion is. I was going to be prepared to argue with them, "That's not what discussion is."

In an interview, she said,

> In the past, I thought that the discussion time could be used for something else more productive. Now, I see that discussions can increase student skills- that transcends content… I want students to talk in order to be able to interact with the world.

Ms. Lewis was skeptical and hesitant to try new types of discussions when she first started attending professional development. Over time, as we watched video of enactment and continued to read and discuss research articles, Ms. Lewis modified her view of inquiry-based discussions, as shown in the interview excerpt. She stated that she wanted to try engaging her students in open-ended discussions more frequently; it was something she was not doing at the time. The curriculum represented open-ended discussions as problem-solving discussions, which may involve challenging other students, debating, argumentation, and the use of evidence.

I showed in Chapter 4 that Ms. Lewis stated a goal of enacting open-ended discussions after watching Ms. Ina enact one through video. She stated in Chapter 4,

> I would like to try some of the same things. I am curious to see how my kids react. Because where your kids are, mine aren't. But I would like to get them more towards that. I think it's going to be a battle.

However, open-ended discussions had the potential to compromise the structure and comfort that she worked to accomplish in her classroom. She recognized that this type of instruction would be a "battle." Earlier, I mentioned that one way she maintained structure was by controlling the type of discussions she enacted; limiting them to discussions that had predictable answers and sequence progressions. According to Ms. Lewis, these types of discussions were low risk; making her more willing to try them. In an interview, Ms. Lewis talked about the

types of discussions she preferred to do in class and how they related to the comfort levels in the classroom.

Researcher: So, I remember talking in our planning session, I think the last one, we had, we talked about reviewing discussions, versus the generating discussions, versus the problem-solving, and how it was more difficult to do the problem-solving. I don't know if it was more difficult, but the reviewing and generating, you guys did them more frequently and found them more easy to do.

Ms. Lewis: Yes.

Researcher: Why did you find them easier?

Ms. Lewis: I think the students are more comfortable with them. I mean, a lot of them have been trained from early on that here's your information, learn it and be able to spit it back out. And reviewing just seems that… taking that to the next step. And so, I don't think that it's necessarily the way it turns out, but I think that they might not all know about what we are reviewing, but they all know something. So, they feel more comfortable throwing out ideas there. And the generating is kind of brainstorming, and there isn't necessarily a right or wrong answer, and that also generates a certain level of comfort. And so I think the students are just more comfortable with it. And from my own viewpoint, I think I have just had more experience with doing that, both as a student and as a teacher. So, that increases my comfort level with those too. Where as the problem-solving, from the standpoint of the teacher, can be kind of open-ended and that can be scary, because you are never quite sure where it's going to go. And how do you decide when it's a good place to stop? And it can be a little bit more time consuming. So, those are the reasons why I think generating and reviewing are more common, at least in my classroom.

Despite the expression of wanting to do problem-solving discussions during professional development, in the interview transcript above, Ms. Lewis talked about doing reviewing and generating discussions more frequently to

maintain her comfort and the students' comfort. She argued that these discussions allowed her to prevent unknown interactions and took less time. During a generating discussion, students were encouraged to brainstorm ideas and assess prior knowledge. The students were not necessarily required to venture into subjects that were unknown to them. During a reviewing discussion, students talked about content that was already experienced through an activity or reading. Reviewing discussions do not necessarily bring out new subject matter that Ms. Lewis could not address; thereby allowing Ms. Lewis to control the direction of the discussion. Reviewing and generating discussions were low risk instructional changes that Ms. Lewis could make, without jeopardizing established classroom norms.

Ms. Lewis contrasted reviewing and generating discussions with problem-solving discussions by saying that the open-ended nature of problem-solving discussions made them difficult to enact, especially since she had little experience with them. In lines 21-22, she described problem-solving discussions as "scary because you are never quite sure where it's going to go."

Ms. Lewis expressed "fear" of problem-solving discussions, even after stating that she wanted to enact more of them, but also gave three reasons for this fear. First, as the teacher, she could not control the direction of the discussion. Second, knowing how and when to conclude the discussion was difficult for her. And third, time constraints made it difficult to fit the discussion in a class period. Ms. Lewis may have sacrificed elaboration and explanation due to

large amount of content to cover in a short amount of time. Unknowns made the enactment of discussions uncomfortable for Ms. Lewis.

Similarly, Ms. Lewis talked about engaging students in generating and reviewing discussions because they were also comfortable for the students. In the transcript above, Ms. Lewis implied that she wanted the students to feel uninhibited participating in and contributing to reviewing discussions. She said, “They all know something. So, they feel more comfortable throwing out ideas there.” Brainstorming discussions produced a similar type of comfort among the students. She said, “there isn’t necessarily a right or wrong answer, and that also generates a certain level of comfort. And so I think the students are just more comfortable with it.” Here, she continued with the same line of reasoning; maintaining a level of familiarity prevented students from feeling uncomfortable with being “wrong;” something they might experience in a problem-solving discussion.

The below transcript further elaborates Ms. Lewis’ description of student comfort. Ms. Lewis described why students were uncomfortable with discussions that required argumentation or disagreement.

Ms. Lewis: Right, so… I think that a lot of them are bringing what they have at home and expecting it to be that way. There is discomfort. Kids come in fire and brimstone. Parents say, “So he doesn’t talk back?” “No, but we have trouble getting some actual discussion going.” “But, he doesn’t talk back?” But… I don’t know how to overcome that, but they are starting to see that it’s ok to disagree as long as you do it the right way.

Researcher: So, the parents are actually coming in saying…

Ms. Lewis: We have some parent-teacher conferences where they are concerned about behavior. My standard response is, “If there is behavior trouble, you will hear from me.” I had a discussion with a grandma that I would like her granddaughter to disagree with me and it’s not a sign of disrespect. And the grandma said, “Well, you’re the authority”, and I don’t want to be the authority, I want to be the teacher.

Student culture did not permit them to “talk back” to, or argue with authority figures, including teachers, also making the enactment of problem-based discussions difficult. Ms. Lewis gave an example of a parent she had a conversation with. This parent was concerned that her child was talking back to the teachers, regardless of Ms. Lewis’ numerous statements that disagreement in some situations was welcome. Ms. Lewis also referenced teacher roles in inquiry-based classrooms. When teaching through inquiry, the teacher’s role changes from controlling the activities in the classroom to facilitating the activities (NRC, 2000). As a result, the students’ roles also change. Rather than being passive receptacles of knowledge, they learn to take ownership of their own learning (NRC, 2000). During inquiry-based discussions, students learn to exchange information, explain, and clarify their ideas, consider others’ ideas, and expand their understanding. However, Ms. Lewis encountered opposition from the students’ parents, shedding additional light on how their previous experiences influenced their engagement in science discussions.

In Chapter 5, I showed that professional development conversations shifted from requesting student engagement strategies to thinking about how student experiences contributed to the difficulty of enacting inquiry-based discussions. Ms. Lewis’s hesitation to enact problem-solving discussions is consistent with this shift. Ms. Lewis altered her instruction to meet the comfort

levels of her students, even though she omitted some inquiry-based discussions. She chose to compromise certain discussions in order to prevent adding to the students' stress levels from home and from other classes.

In summary, Ms. Lewis's participation in professional development helped her begin to make instructional changes in attempts to enact inquiry-based discussions. She seemed to use professional development as a way to talk through her fears and doubts of inquiry-base discussions, and make decisions about how to support discussions in her classroom. Although she expressed her willingness to experiment with difficult types of discussions, she also talked about different conditions that led her to limit her students to low-risk discussions, like generating and reviewing discussions. Conditions like student culture and time constraints increased her fear levels, and instructional changes in the classroom seemed less visible. However, her choice to incorporate generating and reviewing discussions to her classroom routine demonstrated instructional change.

Small Changes During Instruction Reflect Professional Development Goals: Using Specific Strategies Within Discussions

Student comfort was important in Ms. Lewis's choice and delivery of strategies while enacting discussions, and as a result altered her professional development goals. Ms. Lewis's avoidance of uncomfortable interactions in the classroom seemed to limit her enactment to teacher led strategies. I define a strategy as an instructional approach to achieve discussion goals. Although her enactment of teacher led strategies may be perceived as an unsuccessful enactment of inquiry-based discussion, I argue that within the constraining

conditions I described in previous sections of this chapter, Ms. Lewis worked to introduce her students to different ways of engaging in science discussions, especially since discussions were new for them. In Chapter 4, Ms. Lewis stated that her goal was to use the public document regularly and to encourage students to challenge her during discussions.

For example, in the excerpt below, Ms. Lewis engaged students in a reviewing discussion about a reading on skin color. In this excerpt, multiple students participated in the creation of the public document and Ms. Lewis allowed a student to create the public document on the board, but none of the students talked directly to each other, nor challenged the ideas that were presented. When an unclear idea was stated, Ms. Lewis stepped in and clarified the response, rather than asking another student to assist. Ms. Lewis did not push students to explain themselves or explore similarities and differences among student ideas, perhaps to allow students to feel that their contributions were valuable parts of the discussion.

Ms. Lewis: So, what I want to know and what we are trying to build on the board is what you learned about tyrosinase from reading this article. What does it do? How does it work? Where does it happen?

S1: It says it's an assembly line.

S2: It's the first thing that works in the assembly line.

Ms. Lewis: Point number one, you are saying that it's a molecule, specifically, it's an-?

Multiple students: Enzyme

Ms. Lewis: Ok.

Student writes enzyme on the board.

S3: Tyrosinase is the first enzyme to act in the process to make melalin (mispronounces melanin).

Multiple students: Melanin!

S4: It produces melanin.

S2: It speeds up reactions in the body.

S5: Skin color is dependent on tryosin.. blah blah blah.

Ms. Lewis: Helps determine skin color.

S6: Do we need to write this in our book?

Ms. Lewis: No, it will be on the board.

S6: Forever?

Ms. Lewis: Not forever. We will replace it with something else.

S3: If there is no trysosisnis (mispronounces tyrosinase), there is no melalin (mispronounces melanin).

Student at the board: Anything else?

Ms. Lewis: Does anyone have anything else to put on the board?

Multiple students: No

When Ms. Lewis explained why she chose reviewing and generating discussions over problem-solving discussions, she mentioned that multiple students could contribute known information to the discussion without feeling insecure about their contribution. Reviewing and generating discussions prevented discomfort in talking about concepts they did not know or understand. The excerpt above is a curriculum suggested discussion. The curriculum asked the teacher to engage students in a reviewing discussion about a reading on tyrosinase. In the enactment of this discussion, Ms. Lewis deviated from inquiry-based practices. For example, the students responded to her initial question with "It says," referring to the article they read. Ms. Lewis changed the sources of knowledge in her follow-up response to "*You* are saying," (italics added for emphasis) indicating that the idea came from the student, even though it did not. This move by Ms. Lewis may demonstrate her maintenance of student comfort and feeling valued during the discussion. Rather than asking the student (or another student) to rephrase the book's explanation into the student's own words, she transferred ownership of the knowledge onto the students.

While responding to the students, she rephrased the students' words to fit the answer she was looking for, with no explanation, "it's a molecule," then asked an unfinished recall question for the students to complete. In lines 18-27 the students offered ideas about how skin color, tyrosinase, and melanin were related. Several students called out answers, and in line 29 Ms. Lewis paraphrased and condensed the answers for the students. Finally, Ms. Lewis

asked the class if there were other ideas to be added and the students answered, “No.”

Many of the practices I described may seem as though Ms. Lewis lacked consistency with her professional development goals; perhaps she feared making students uncomfortable. However, I will highlight practices that aligned with her goals (see Table 6-4). In Chapters 4 and 5, I showed that the teachers wanted multiple students to participate in discussions. In the above excerpt, at least six students participated in the discussion. Although Ms. Lewis often intervened to alter the student responses to match the textbook answers, she encouraged students to speak in class. According to Scott, Mortimer and Aguiar (2006), this discussion had a low level of interanimation of ideas. They may describe this type of discussion as, “Different ideas are made available on the social plane. For example: teacher lists student ideas on the board” (pg. 611). Although this discussion was not, by definition, dialogic (Nassaji & Wells, 2000; Polman, 2004; Scott, et al., 2006), Ms. Lewis made an attempt to engage multiple students in a discussion.

Recall, in Chapter 4, Ms. Lewis talked about students refraining from challenging her because they positioned her as the authority. In that case, Ms. Lewis recognized that the students had difficulty with large discussions, perhaps due to barriers outside of her classroom (feeling “frazzled,” being screamed at in other classes, and being discouraged by their parents), and structured the class to foster comfort through smaller discussions, or ascending discussions. For example, she talked about a student who did not like speaking in class, and the

use of ascending discussions allowed him to feel comfortable speaking. Although he only spoke to her, she acknowledged this student's change as progress.

In an interview excerpt in Chapter 4, Ms. Lewis talked about using ascending discussions as a way to increase student comfort before engaging them in larger discussions. Although not shown in the above excerpt, Ms. Lewis told the students to think about what they learned about tyrosinase and asked them to work in pairs first (not shown in excerpt above). After students finished sharing ideas with their neighbors, she reconvened the class in an attempt to have a whole class discussion (above excerpt). Again, Ms. Lewis' concern was with the students' emotional response to the discussion; she chose strategies that would maintain the students' comfort levels.

In addition to ascending discussions, Ms. Lewis used the public document as another strategy to increase student engagement during discussions. In the previous classroom excerpt, Ms. Lewis designated a student to record class responses on the board. The transcript below is from the professional development, after watching a video of Ms. Ina's enactment. Here, Ms. Lewis talked about her initial fear of using a public document during a discussion.

Researcher: I liked how you had Jenny doing all of the writing. She is a handful. I liked how you had her be the one, since she likes to have all the attention. You said, "Here you go." It allows her to focus that onto something that can contribute to the classroom. So, that was a good move. Any other comments or observations?

Ms. Lewis: I was thinking if I had someone go up to the board and write, how many people I would have sulking. "Why her and not me?" [Teacher voice] "It can be you next time."

In the transcript above, Ms. Lewis commented on how she thought the public document had the potential to create jealousy among the students. Again, Ms. Lewis related the public document to the students' emotional responses. In Chapter 4, I Ms. Ina used the public document in her classroom and Ms. Lewis stated that it was something she wanted to try as well. Later, Ms. Lewis stated that she liked using the public document and that the students were receptive to it. Over time, after watching Ms. Ina's enactment using a public document, Ms. Lewis was inspired to include it in her instruction. In the excerpt below, Ms. Lewis talked about the public document during another interview.

Researcher: And did you ever, after talking about the criteria and how they played into the different types of discussions, did you ever find yourself making changes to the things you did based on, you know, the different criteria that we looked at?

Ms. Lewis: Absolutely. I think probably the most obvious one is just this idea of generating a public record. And that I found to be very helpful and I can certainly see myself continuing on with that. And not just for me, but I think the students found it helpful because it helped to focus them. I mean, they can talk all the day long and never talk about anything, but when they see that something is being produced, some sort of public document, something on the overhead or something on the board, then the very act of constructing it gives them some satisfaction. It makes them feel more intent on contributing to the discussion. You know, they want to see their words written down.

Ms. Lewis said that the public document was helpful to the students. She explained that it helped provide satisfaction among the students. Although her attitude towards the public document changed, the reasons behind it were the same- the students' emotional response, or student comfort. Again, Ms. Lewis

stated that she wanted the students to feel like they were contributing to the discussion, and the public document helped with that.

The strategies Ms. Lewis chose continued to show the tensions she faced with inquiry enactment. Throughout professional development, she stated that she wanted to try difficult discussion practices, like giving students ownership of the discussion, problem-solving discussions, increasing student individual ideas, and encouraging confrontation among students and with her. She set challenging goals of instruction for herself. However, Ms. Lewis described several conditions that constrained the enactment of difficult inquiry-based discussion practices. As a result, not only did she decide to hold discussions that did not require argumentation or confrontation, but she also chose strategies that only uplifted the students.

Ms. Lewis's enactment shows that inquiry-based discussions do not happen automatically. They take time to establish in the classroom and are under several constraints, like time, student and teacher comfort and familiarity, and prior experiences and influences outside of the classroom. Ms. Lewis juggled several constraints when making enactment decisions and chose to enact discussions and use strategies that preserved classroom comfort. In an interview with Ms. Lewis, she also acknowledged that her discussions were not yet dialogic, but slowly moving towards it.

Researcher: Based on how we used the term "dialogic" in the planning sessions, do you think your discussions are more dialogic? What about them made them dialogic?

Ms. Lewis: I don't know that we are there yet. I would say that we are approaching it. We are moving towards dialogic discussions. I don't have any expectations of getting there this year, but I might get there next year. [She has approximately 80% of the same students next year.] We still have a ways to go. It will most likely happen next year.

Ms. Lewis recognized that she and her students had a lot of work to do when it came to engaging in dialogic discussions (line 7). She stated that it would take several months (the remainder of the school year- another 2 months- and the next year) and the same group of students to move closer to dialogic interactions in discussions.

Ms. Lewis's response helps conclude my argument in this section. Although professional development can help teachers set instructional goals for themselves, changes in teacher enactment may occur at different rates due to conditions teachers experience in and out of the classroom. Here, Ms. Lewis struggled to balance tensions of her instructional goals with fear of practices that she did not trust, and issues of student comfort. Rather than arguing that Ms. Lewis did not change enough or at all, I argue that Ms. Lewis's change fell on a continuum of instructional change. She started with inexperience, doubt and hesitation and moved to experimenting with two out of three of the different discussion types presented in the curriculum, and strategies that could help increase student engagement in the classroom. Although her experimentation was low-risk, she made an attempt, and stated that she planned to continue with inquiry-based discussion practices until she reached dialogic interactions.

MS. INA

Enacting Inquiry-Based Discussion: Tensions Between Professional Development Goals and Real-Time Enactment

In the first professional development workshop, Ms. Ina talked about what she wanted to learn from the meetings. During this conversation, Ms. Ina stated that she was looking for the "same things" as Ms. Lewis and Ms. Kline, which were to find ways to incorporate discussions into her lessons and to engage students in those discussions.

Ms. Ina identified tensions that she faced while teaching. During the conversation, she said, "it's easier for me to say that this is how it is, because that's the way I was taught. I want to stand back and let them build that information so that they come up with the answer." In this comment, she referenced going against pedagogical techniques that she was taught with. Although she did not explicitly describe them here, her contrast of "stand back and let them build that information," implies traditional teacher led didactic teaching versus student led constructivist teaching. Ms. Ina wanted to abstain from traditional ways of teaching, although it was easier and familiar to her, and move towards constructivist teaching styles, such as inquiry. However, in the initial conversation, Ms. Kline commented on the difficulty of teaching through inquiry-based methods. Later, Ms. Ina followed-up on and expanded that concern (see Chapter 4), by criticizing inquiry-based instruction, saying that it did not work in urban classrooms.

Over the course of 12 weeks, Ms. Ina's consistent participation in the professional development workshops revealed that she wanted to understand

how to enact inquiry-based lessons in her urban classroom. Based on the statements she made during professional development, I found two main themes (see Table 6-3). First, in order to effectively teach inquiry in her classroom, she needed to overcome negative feedback in her community. During professional development, she commented that the negativity came from all sides, and that the lack of support from the school made it difficult for her to teach and for students to learn. Second, Ms. Ina wanted to learn how to encourage her students to take ownership of inquiry-based discussions, to think individually and refrain from acquiescence. In Chapter 5, she commented that she wanted the students to recognize that they had "a lot inside of them." She wanted her students to not only recognize their capabilities, but to also act on them, by stepping out and speaking up for themselves, despite the negative feedback from the school community.

Similar to Ms. Lewis, Ms. Ina faced negative school conditions that made the enactment of inquiry-based discussions difficult; she dealt with lack of school support. In Chapter 5, she described the way the school let the students "wander" and did not have "control" of the students. She stated that there were no consequences for student tardiness, and that it discouraged her. She summarized it by saying that "there are so many things lacking in the system." Ms. Ina also described a negative attitude from other teachers. She stated that teachers questioned her involvement in professional development, since "nobody cares." In addition, she talked about a lack of community support [most likely her friends and family], saying that people were surprised when she mentioned that

he worked in Flint. Regardless of the negative feedback from the school, school system, and community, Ms. Ina continued to pursue improved instructional practices that would help her enact inquiry-based discussions.

In this section, I will show that Ms. Ina's enactment was consistent with her goals and concerns during professional development. First I will show how Ms. Ina described the discouragement that came from her school community and it's affect on the students. From watching the videos, Ms. Ina talked about being motivated to persevere. Rather than allowing the lack of school support to disrupt her goal of achieving inquiry in the classroom, she applied the solutions discussed during professional development to overcome instructional obstacles. Secondly, I will show that Ms. Ina made behavioral modifications and employed specific strategies to encourage the students to take ownership of discussions and express individual ideas and thoughts.

Like Ms. Lewis, Ms. Ina wanted to make inquiry a part of her teaching practice, however, she differed in her willingness to make herself and her students uncomfortable, even if she did not completely trust research-based methods. In fact, Ms. Ina never described a previously established classroom structure or comfortable environment that she wanted to maintain. She often expressed that there was a lack of control in the school (high levels of tardiness and absenteeism, students wandering the halls, etc) and attributed negative student attitudes to it. It is possible that Ms. Ina was eager to find a solution due to the lack of "structure" and "comfort" in her school and classroom, and did not

feel as though there was anything to lose, since it was never established in her classroom.

INQUIRY				
Ms. Ina's Tensions	Distrust for Research Based Methods	Getting Past A Negative Community/Lack of Support	Avoiding Classroom Conformation	
			Students have information inside of them	Students take ownership of discussions
Teaching Approach	Push through the discomfort	Appreciate student progress	Students ask more questions	Teacher steps back (Behavioral change)
		Provide structure	Students stand on feet and speak out	Use public document (employment of strategy)
		Persevering beyond familiar institutional teaching practices	Students express their individual ideas	Use think/pair/share (employment of strategy)
		Stop yelling at students		
Additional Tensions		Negative teacher feedback	Frustration among students	

Table 6-3: Ms. Ina's Tensions While Enacting Inquiry-Based Discussions

In addition, she stated that she thought, "students had information inside them," which could have also contributed to her eagerness in finding a solution. As a result, she may have been more willing to take greater instructional risks and make significant changes to her instruction. Although each teacher faced similar tensions in the classroom, their school conditions and ideas of teaching and students contributed to their instructional approach. In the next sections, I

will show that Ms. Ina recognized student discomfort yet continued to discourage complacency. Her willingness to push her students towards engaging in inquiry-based discussions helped her demonstrate changes in her instruction that were consistent with her professional development goals.

Overcoming Negative Feedback in School: Promoting Inquiry-based Discussions in the Classroom

Participating in professional development afforded Ms. Ina the opportunity to recognize several factors contributing to her instructional difficulty. In this section, I will show that regardless of the student engagement Ms. Ina showed progress in, she continued to struggle with self-doubt as a result of school and community negativity. In Chapter 4, Ms. Ina stated that despite the negative reputation of her school and students, watching video gave her a better view of herself and her students and helped her appreciate the progress her students were making. She also stated that she was able to see that positive things were happening in the classroom and that there was an increase in student engagement. However, she did not receive validation or encouragement from other teachers in her school; which discolored her view of herself and her students. The excerpt below is from a conversation between Ms. Ina and Ms. Lewis, where they described negative reactions from school colleagues.

Ms. Ina: I had a teacher pick up the student reader. And she said, “Your students are doing this?” And I said, “Yes,” and she just rolled her eyes like, “Yeah right.” Like, they’re not getting this. They have nothing in them to engage in those types of assignments. And that’s what’s been so frustrating all along. Teaching for the district that I am in. Because that’s how the students are looked at. And I think that they pick up on it and they themselves begin to believe it.

Ms. Lewis: I got pulled out of class on Thursday to meet with state auditors. And they said, “Where have you been?” I said, “Teaching.” They said, “Teaching?” I said, “I know, the nerve of me, teaching.” They said, “What were you teaching that was so important.” He was kind of joking, I said, “Transcription, translation, and proteins.” You see him writing, “Oh, you really were teaching.” Yes, that’s what I do, I teach. The other woman there after the meeting came into my class to watch what was going on. It just stunned me that she was stunned. Well, what do you think we do all day?

In the excerpt above, Ms. Ina and Ms. Lewis expressed their frustration with their school community. Both teachers talked about a negative reaction to the content being taught from their colleagues. Ms. Ina said that it was frustrating to teach in a school with low expectations of the students because the students responded to those expectations and it was discouraging for her as a teacher. She said that the students “begin to believe it themselves” (line 6). This is similar to Ms. Ina’s comments in Chapter 5, where she said that the students “just do anything” and blamed it on the lack of support in the school halls and the school in general. According to Ms. Ina’s statement above, the students’ “just do anything” attitude may have been a response to the low expectations from the school community.

To address the lack of support from the school, Ms. Ina depended on instructional strategies that would provide guidelines for herself and the students. For example, in the interview excerpt below, Ms. Ina talked about using the discussion supports that we created in the professional development as a guide. Her goal in this case was to get the students engaged in a discussion. She did not specify a content goal, but wanted the students to show that they were capable of having a discussion.

Researcher: So, one of the things that I am also interested in, in the second question is, how did you organize your discussions in the classroom? Did you go in with a set idea of how you wanted to see the discussion happen, or did you let it kind of take on its own… how did you know that your goals were being met throughout the discussion?

Ms. Ina: I think I probably just went in and let it roll. Which is why I am saying that I would probably use the charts that you came up with to guide. But as far as the goal, it was whatever the topic was, whatever the question was. I don't I see beyond that, as far as what to do, or what I want them to say, you know? I think I just let it happen. So, as far as the goals, if the goal was met, just getting them to discuss, and maybe that's not setting the standard very high, but just to get them going on the discourse. If that was successful then I believe that the goal was met. Especially since at first, they were just looking and not wanting to discuss anything or say anything. So even if they are arguing, I like that. As long as it doesn't get out of hand.

Ms. Ina expressed that her main goal was to get the students talking, regardless of whether it was a "good" or "bad" discussion. In lines 12-13, she said that initially students did not want to participate in discussions, perhaps because they were unfamiliar with the format, content and interaction patterns, or because they did not believe that they had the skills to participate. Ms. Ina said in line 11 that she might not be setting the standard very high, but she wanted them to begin to engage in a different way. In order to achieve classroom discussions, she mentioned the use of charts. The charts she referred to were the written discussion supports. In her mention of the supports, she referred to them as "guides." Similarly, in the next excerpt, she referred to the charts as a guide that would help her structure the unit.

Researcher: So, the charts that we made, I am calling those the supports. How do you think the charts, or the supports influenced, or had an affect… how do you think the

presentation of them, in the chart form, impacted your teaching in any way? Did you find that it did anything?

Ms. Ina: I could see them being… it just gives a lot of structure to the whole unit, and a guide that you can see. And you can look to see how it is that you want to present whatever it is that you are presenting. So I think that I can see them being extremely beneficial.

As Ms. Ina attempted to overcome the lack of school support and negative comments from the school, she looked to the written curricular supports to help her enact inquiry-based discussions. In the above excerpt, Ms. Ina specifically stated that the charts could be used as a guide to structure the unit. From Ms. Ina's description, I define structure as the organization of the unit, an individual lesson, or a discussion. For Ms. Ina, organization came in the form of the written curricular supports, which were the charts developed in professional development. According to Ms. Ina, the supports acted as a guide, or something to lead her through a discussion. Within the supports were strategies that helped her accomplish the goals of a discussion. However, regardless of her progress in achieving inquiry-based discussions, she continued to encounter negative feedback from other teachers and frustration from students. Below is an excerpt from an interview with Ms. Ina. Here she stated that the students were hesitant with learning through inquiry.

Ms. Ina: I can't put my finger on it because it's [inquiry] based on prior knowledge and the student expectations and certain understandings and they are supposed to put the pieces together. But there is always a hesitation and I don't know how to overcome that part; of giving their educational process to them back in their hands.

In line 3-4, Ms. Ina commented that she did not know how to overcome student hesitation with inquiry. She pointed to different parts of inquiry that she wanted to accomplish (giving the educational process to the students- line 4), but found it difficult due to student unwillingness. Although the students were hesitant, Ms. Ina recognized that they were progressing in their learning process. Watching video of her enactment, she acknowledged her success in inquiry enactment, and her students' success in participation. In the excerpt below, Ms. Ina and Ms. Lewis review a video of Ms. Ina's teaching and student engagement.

Ms. Ina: And in my mind, that's my worst class. I think that I only see the negative. Then I watch the video, they were engaged and it's not the image I have of them. Because they give me such a hard time.

Ms. Lewis: They are so much calmer than my class. I was like, wow.

Ms. Ina: Part of the problem is that many of them in the video don't come.

Ms. Lewis: It makes it hard.

Ms. Ina: I don't even know how to begin to address that. There is so much in them.

Researcher: Does that change anything for you as far as…

Ms. Ina: It's encouraging. I think that's a lot. Especially, I am just in a negative community. And the students are being viewed as negative and I feel like I am spinning my wheels and that's not true.

Similar to previous comments, Ms. Ina had difficulty recognizing the success of her classroom practices and her students' learning due to negative comments from other teachers and the "just do anything" attitude of the students.

However, in the above excerpt, her perception of the students changed to reflect their progress. Ms. Lewis responded with admiration saying, “They are so much calmer than my class. I was like, wow.” Although Ms. Ina acknowledged the students engagement in discussions, she continued to focus on the lack of school support. In line 7, she commented that the high level of absenteeism in her class also made instruction difficult. Later, in line 16, she said that she was encouraged by what she saw in the video, but negativity from the community made her feel unfruitful.

The enactment of inquiry-based discussions seemed to have the added constraint of little support and negative feedback from the school. Ms. Ina not only had to encourage her students to think highly of themselves, but she also had to overcome self-doubt while enacting inquiry-based discussions.

Promoting Student Ownership of Discussions and Avoiding Classroom Acquiescence

The enactment of inquiry-based discussions can produce student resistance, requiring a change in teacher instruction and increased perseverance. One of the instructional goals expressed in professional development (see Chapter 4) was to increase student engagement and ownership of discussions. Although the excerpts above described Ms. Ina’s students as showing improvements in inquiry-based discussion engagement, Ms. Ina continued to complain that her students conformed to one idea and were hesitant about offering individual ideas. Ms. Ina responded to student acquiescence in two ways. First, she recognized that the students “had a lot of information inside of them.” Second, Ms. Ina said that she wanted the students to

take ownership of the discussions. In this, she wanted to intervene less, and used strategies that required students to construct their own knowledge. In this section, I show how students relied on particular students to provide answers, how Ms. Ina talked about addressing the issue, and how she addressed the issue during enactment. In the excerpt below, Ms. Ina and Ms. Lewis shared experiences of student acquiescence and ideas of changing conforming behavior.

Ms. Lewis: My kids are pretty competitive. There are a couple that don't say anything, so they will funnel all their questions through one student. I'm like, "No Chanel can't ask all of your questions." Chanel asks the questions for everyone and we know they are coming from you, now you answer.

Researcher: It's funny how Chanel will take on that role. Is she one that likes to talk?

Ms. Lewis: The thing is that she thinks that if she does that, then she won't have to share any of her own ideas. She is comfortable being a mouthpiece. "No Chanel, I want one of your questions." (Gestures Chanel cowering)

Ms. Ina: That's so interesting.

Ms. Lewis: And I think I always knew that, but in the coarse of lesson one, I think its been emphasized. It's been really interesting to see.

Ms. Ina: Mine will just go with a couple that are in the forefront and just, "Oh yeah, that's what I am thinking," instead of relying on their own.

Ms. Lewis: Mine get mad. I had that idea. It's okay. It doesn't belong to him.

Ms. Ina: I had that too this week. They say, "I can't say that anymore, they already said it."

Researcher: How do you handle that? If someone has something to say and someone else already said it, how would you get them to…?

Ms. Ina: I guess next time, I'd say that's probably true, but you also have something else to add because you can't possible both be thinking exactly, exactly the same thing.

In this conversation, Ms. Ina and Ms. Lewis expressed an enactment issue. They described students using particular students in the classroom as the "mouthpiece" for the whole class; all the students relied on one person to speak for the rest of the class. It is a common problem for teachers to rely on one student to produce correct answers (Tobin & Gallagher, 2006). In the above situation, the students depended on particular students to produce the correct answers, thereby releasing them from responsibility and individuality. Although I recognize this as part of student socialization into classroom norms (I am calling this phenomena student acquiescence), my focus is on how Ms. Ina addressed this issue. In line 18, Ms. Ina said that her students relied on the students in the "forefront," or the students who were academically successful, for the right answers and did not think for themselves. When I asked Ms. Ina how she planned to address this issue, she said that she would push them to produce alternative thoughts and ideas. "You can't possibly both be thinking exactly, exactly the same thing," implies that Ms. Ina wanted her students to show individuality in their ideas, which is consistent with her comment that each student had information inside of them in Chapter 5.

To address this issue, I asked Ms. Ina how she planned to encourage individual thinking. In the interview excerpt below with Ms. Ina, she talked about

providing the students with guidelines to help them generate their individual thoughts.

Ms. Ina: When you tell them to think about it, give them these guidelines. Guidelines about the questions- How does this help you think about other times? When I did that think-pair-share, they were like, “Where did you get that?” And when I said, “We were going to do it,” some of the ones that just speak out started saying, “Think”… they just started (gestures speaking with hands and arms). And there are others that rely on others to think, so the think-pair-share helps every individual.

Similar to a previous statement by Ms. Ina, she relied on supports to help her organize classroom discussions. In this case, she used a strategy from the support, the think-pair-share, to provide organization to student thinking. She stated that the think-pair-share strategy gave the students guidelines to help them think about different topics. In contrast to the conversation with Ms. Lewis about student acquiescence, here she talked about students telling each other to think for themselves, making the think-pair-share a useful strategy to break uniformity of thought. In addition, Ms. Ina used the public document as a strategy to encourage student expression of individual ideas. Ms. Ina not only wanted the students to generate their own ideas, but she also wanted the students to interactively express them to each other. She wanted to be able to remove herself from the discussion and allow the students to lead the discussion by interacting with one another, exploring ideas, and asking and answering questions on their own. In an interview, when asked about the public document, she said, “The public document… you can ask about what we know about… what do we want to formulate from it, encouraging them to address each other.”

In the excerpt below, Ms. Ina and Ms. Lewis talked about using the public document to promote student interaction and thinking.

Ms. Ina: It generates lots of discussions too. It gets them interacting.

Ms. Lewis: Plus there's colors. It makes so much difference to them. Which is also true if you use big post its and markers.

Ms. Ina: You can really look into what they are thinking. The last one I did, I had three columns. What do we know, what questions do we still have and what do we conclude. So, it's the whole… I think that was on sickle cell. At the conclusion, both classes came up with sometimes its not a bad thing. If you are a carrier, it can be an advantage. It's a different take than just looking at mutations all being bad. Oh, and this happened last year as well; for the "What questions do we have?" last year and this year, they both said, "Can they somehow use sickle cell anemia to cure AIDS?" Which whether they can or can't, I think that's good question.

Researcher: So it's having them generate good questions while they are thinking about other things.

Ms. Ina: And for me as a teacher that's exciting. That they're making these connections to the world around them and to what they learn in the classroom. And I'll say I don't have any idea, sickle cell, red blood cells, AIDS, but I don't… but this is something that perhaps one day you could look into. I get to talk about college and going on after the four years and all that. So that's exciting for me.

Ms. Ina wanted the students to think beyond what they were learning in class and avoid conforming to one class idea, and instead ask questions that were unfamiliar and interesting to them. In the excerpt above, Ms. Ina and Ms. Lewis began by talking about the public document. Ms. Ina stated that it was good for promoting student interaction. As the conversation progressed, Ms. Ina

elaborated on another advantage of the public document- question generation. Ms. Ina was not concerned about having the correct answer; she wanted the students to learn to generate questions in science. This differs from Ms. Lewis's maintenance of classroom comfort. Earlier, Ms. Lewis stated that she feared conversations that ventured into topics that she was unfamiliar with. Here, Ms. Ina encouraged those topics. Similarly, in the excerpt below, Ms. Ina revisited the idea of asking questions.

Ms. Ina: When I have an opportunity, I like to tell them that its not so much the answer that's the big thing, it's the question. Because, that's what keeps the process of science going; are the questions. You know, that it's ok that you get a wrong answer. Then I have to tell them that you may not be wrong. And that it may lead to other questions, and that's what you really want to generate.

Ms. Ina specifically claimed that being able to ask good questions is the important part of science and that getting the right answer is not necessarily of the essence. She went on to say that wrong answers could lead to additional questions. In Chapter 4, I showed that during professional development conversations, Ms. Ina expressed that her discussion goals were to encourage students to control the discussions, express their individual ideas and thoughts, and interact with one another. She used think-pair-share and the public document strategies to push her discussion agenda forward.

Demonstrating Instructional Changes That Reflect Professional Development Goals

Professional development provided the teachers with opportunities to set instructional goals for themselves. The following excerpts demonstrates Ms. Ina's change in her discussion enactment according to her professional development

goals. Both discussions were reviewing discussions. In the first excerpt, the students reviewed the process of transcription and translation, and Ms. Ina controlled and led the discussion, by asking follow-up questions, such as, “how come?” and creating a public document on the board. In the second excerpt, Ms. Ina intervened less and allowed the students to take ownership of the discussion. In both excerpts, Ms. Ina used the supports to guide her instruction, but over time, she incorporated more of the strategies that would encourage classroom conversation among the students.

Ms. Lewis: What did you get for a codon?

Ron: I don’t know.

Tina: It is um…

Ms. Ina: Tina raised her hand.

Ron and Jenny: She had to brag huh; because the camera is on.

Tina: It is a three-letter code for an amino acid.

Ms. Ina: A three-letter code for an amino acid.

Jenny: It determines the amino acids when you are doing it with the, uh, three.

Ms. Ina: Give me a DNA sequence.

Students: T-A-A-C-G-G-T-A-A (Ms. Ina writes on the board.)

Ms. Ina: Now give me the RNA.

Students: A-U-U-G-C-C-A-U-U (Ms. Ina writes on the board.)

Ms. Ina: In RNA, T is not found, so it's going to be U for Uracil. So, here, what we just did, what was that called? There is a term for that. We took the DNA information and got the RNA information. What is that called?

Tina: Transcription?

Ms. Ina writes on the board.

Ms. Ina: And where does that happen within the cell?

Jenny: In the nucleus?

Ms. Ina: Does that happen any place else?

Class: No.

Ms. Ina: How come?

Tasha: Because its finding information. It can't leave.

Ms. Ina: And the DNA has to stay in the nucleus, it's not going anywhere else. (To Tasha) You can look at it that way- it can't leave. So, now, can RNA leave the nucleus?

Tasha: It makes copies of the gene.

Ms. Ina: That's what we just did here, right?

Tasha: Yeah. And then it can leave.

Ms. Ina: We can call this part the gene. The DNA keeps going that way, and that way, and just this part is the gene. (Pointing to RNA sequence.) So now, what happens to this? Where does it go?

Ron: The cytoplasm.

Jenny: Protein.

Tasha: No, it leaves the nucleus and goes to the um…

Jenny: The cell membrane.

Ron: No.

Ms. Ina: I heard protein and then it goes…

Tasha: Its makes proteins.

Ms. Ina: It makes proteins. Where is that protein being made? This is the information that goes to make the protein. Where is that being made? Quinton?

Jenny: He don't know.

Ms. Ina: Tolanda?

Jenny: She don't know.

Ms. Ina: If you looked at a cell from a long time ago, would you remember?

Jenny: Oh, ribosomes.

Ms. Ina: So, this is going to go to a ribosome, and now, how is the protein being made exactly? What's going to happen?

The above enactment transcript demonstrates Ms. Ina's attempt to encourage student discussions. Although many of her questions were recall

questions, she often followed them up with " How come?" or a question that required a process or mechanistic explanation. For example, in lines 25-41, Ms. Ina asked the students a series of recall questions to help the students review simple information, then she followed-up those questions by asking why transcription did not happen anywhere else in the cell. This question not only required that the students bring together ideas behind cell structure and transcription and translation processes, but it also required the students to provide an elaborate response. Similarly, in lines 54-86, Ms. Ina asked a series of simple questions and ended with a complex process question, "how is the protein being made exactly? What's going to happen?"

In the excerpt above, Ms. Ina used the reviewing discussions support to help her enact the discussion. In this support, the teacher was to create a public document, ask follow-up questions, such as "What do you know about this topic?", and encourage student initiated questions and student-student interactions. Similar to Ms. Lewis, Ms. Ina's discussion was not dialogic, and had low interanimation of ideas. Ms. Ina visited and summarized students' points of view, but did not encourage the exploration, comparison, and contrast of those ideas, nor did she promote student-student interactions.

In the next excerpt, Ms. Ina continued to push the students' progression in discussion participation. Ms. Ina took into account professional development conversations and incorporated the ideas into her enactment. For example, during professional development, the teachers talked about student prior experiences interfering with their participation in the classroom (see Chapter 5).

As a result, we decided that students needed to be brought back together as a class and made to feel special. In this discussion, Ms. Ina continued her goal of achieving inquiry-based discussion, while attending to the students' discussion contributions.

Before starting the discussion, she had the students do a think-pair-share on a reading about lactose intolerance. While reading, she asked them to do a pre-reading activity to help them with reading comprehension. The pre-reading activity provided organization of student thinking in preparation for the upcoming reviewing discussion. When the discussion started, Ms. Ina physically moved to the back of the room and asked a student, Jenny, to lead the discussion and create the public document on the chalkboard.

Ms. Ina: The question is why is Jason lactose intolerant. Now, ask the groups what they've written. Ask students what they think.

Jenny: Well, what you have? Oh, what y'all think?

Tina: Jason is lactose intolerant because his body can't make the protein to digest…

Jenny: His body (stops)…

Researcher: You are doing fine.

Jenny: His body, right, can't break down lactase.

Tina and Aretha: Lactose.

Jenny: Lactose. I know, I got it, I got it. (Writes on the board)

Ms. Ina: But we are answering *why* he can't. [Italics added for emphasis.]

Tina: Because his body can't make a particular protein for him to digest it.

Sean: What's the name of the protein?

Aretha: Lactase.

Ms. Ina: So, Jason isn't making lactase. (Jenny writes on board.)

Classroom chatter

Jenny: That's it, that's the answer. What did you say?

Sean: The protein might not be the right shape…

Jenny: It might not be the right shape?

Sean: Yeah, the protein is not the right shape, so it can't do its job. (Jenny writes on board.)

Classroom chatter

Jenny: Anybody else?

Quinton: His body got half the lactase protein, but he ain't got the other half.

Ms. Ina: Is that the same as not being the right shape?

Tina and Quinton: No.

Ms. Ina: What do you mean? Oh, the amount? Are you talking about the amount?

Tina: Yeah.

Ms. Ina: Oh, so he doesn't make enough of it?

Tina: Yeah. He got half of what he needs, but he ain't got the other half.

Ms. Ina: Does that sentence make sense to everyone? His body had half of the lactase?

Sean: I wouldn't say half, because you don't know for sure if it's half or not.

Jenny: But his body…

Ms. Ina: But in terms of, they are trying to say that his body isn't making enough.

Sean: I just wouldn't say half, because you don't know how much he is making.

Ms. Ina: Because when I was looking at it, I was thinking that only half of the protein was made, but that's not what you are saying.

Researcher: [To Quinton] You're OK. Why are you getting upset?

Tina: [To Quinton] You said it right, you just gotta change half to enough.

Quinton: Alright.

Ms. Ina: Are we finished, or are there anymore ideas?

Aretha: I love looking at stuff like this.

Jenny: Jevanna, do you have an idea?

Jevanna: No.

Jenny: Huh, you sure?

The excerpt above shows a change in student participation and teacher enactment. In the first enactment excerpt, Ms. Ina led the discussion and created the public document herself. In the second excerpt, Ms. Ina sat in the back of the classroom and allowed Jenny to lead the discussion. Jenny took the responsibility of calling on students, writing on the board, and contributing to the discussion. Ms. Ina started the discussion with a "Why" question: Why is Jason lactose intolerant? She then instructed Jenny to call on students. Mortimer et al. (2006) stated that if "the level of interanimation is high, they pose genuine questions as they explore and work on different points of view." If the level of interanimation is low, "the different ideas are simply made available" (pg. 611). In this discussion, the students showed more sophisticated interaction patterns; multiple students engaged, students addressed one another, students assisted each other in the formulation of responses, and students questioned and challenged each other's response.

Ms. Ina's enactment was a direct reflection of professional development conversations. Similar to Ms. Lewis's enactment, Ms. Ina started the discussion with a think-pair-share activity for the reading. However, Ms. Ina assigned a reading strategy to help organize the students' thinking. When the students completed the think-pair-share, she reconvened the class to share their ideas in a whole class discussion. The difference between Ms. Ina's and Ms. Lewis's discussion is that Ms. Ina pushed the students to elaborate and/or clarify their responses. For instance, in lines 12-26, Jenny attempted to answer the initiating question. Although her response was correct, Ms. Ina pressed her to give a

molecular explanation. Tina assisted her and mentioned the lack of production of a protein. Another student asked for the name of the protein and Aretha answered with “lactase.” After several turns of student responses, clarifications and questions, Ms. Ina intervened and summarized the responses.

Jenny attempted to end the discussion when she thought the correct answer was stated, but Sean interrupted and provided another possible answer, which furthered the discussion. Afterwards, Quinton offered a possible answer and struggled with word choice. His initial choice of words confused Ms. Ina and Sean, and Tina stepped in to help Quinton. She paraphrased his response, then later turned to Quinton to validate his response. It is important to note here that Quinton expressed frustration when he was challenged by Sean- what Ms. Lewis might have called discomfort with confrontation. Quinton’s reaction demonstrates the kind of reaction that Ms. Lewis avoided. However, Ms. Ina did not back away from his discomfort, and instead pushed him to clarify his response. During this interaction, another student in the class, Tina, stepped in to assist him. In addition, Tina and I, encouraged Quinton, in an attempt to restore his comfort, and he responded with, “Alright.” Pushing through the discomfort demonstrates Ms. Ina’s willingness and eagerness to move towards inquiry-based discussions, regardless of student discomfort.

Although Ms. Ina described feelings of discouragement, her application of the professional development workshops not only helped increase student engagement, but also seemed to improve her perception of her students. The two excerpts above show a shift in her teaching approach. Initially, she

maintained control of the discussion, perhaps due to her doubt in the students' capabilities. In the second excerpt, she utilized several strategies to organize the discussion and engage the students. She allowed the students to ask each other questions and help each other respond. She also pressed for student understanding.

Although Ms. Ina's classroom showed progress in inquiry-discussion engagement, Ms. Ina continued to face opposition and frustration from the students. Ms. Ina struggled to overcome traditional didactic instruction; student familiarity with didactic instruction made it difficult for her to introduce alternative instructional methods. Ms. Ina elaborated on why didactic instruction seemed easier.

> Just there is not much required when you do that (didactic instruction). Nobody is going to bother you and confront you, asking you what you've been through. You are not being challenged. So that's why I think that this practice, this way of teaching, though it takes up a lot of time, I feel they can take it into any classroom and carry it beyond high school and develop those thinking skills and knowing that they have it within them.

In line 1, Ms. Ina said that traditional teaching was not demanding of students, leading to student complacency. She credited inquiry-based discussions with encouraging students to talk about their prior experiences and challenging them in different ways. Again, she mentioned that she wanted the students to recognize that they had information inside of them and to apply the information in settings outside of the classroom (lines 3-4). Despite Ms. Ina's expressed importance of inquiry-based discussions, students still experienced

frustration and rebelled. In the excerpt below, Ms. Ina described an instance when students became frustrated during a discussion.

Ms. Ina: In one of the… I don't think you… no, you weren't here. Well, one of the girls threw chalk at a student and then used profanity, and it just got out of hand.

Researcher: What were they talking about?

Ms. Ina: I don't remember. I think, and maybe it wasn't even anything to do with the topic, as much as it was, "Oh, you're writing too big," or, "That's not what we said."

Researcher: I see. So, they were still uncomfortable with the interaction itself?

Ms. Ina: It might have been that day. I don't know what was happening that day, but it only happened once.

The students were still becoming acquainted with leading discussions and talking to one another, drifted into everyday school language and behavior and away from science language and behavior. In this excerpt, Ms. Ina pointed out an instance of student frustration during a discussion. Such instances demonstrate another tension that teachers faced during inquiry-based discussions; students struggled to navigate between discourses and at times those discourses collided (Moje, et al., 2001). In Ms. Ina's description, the collision caused physical and vulgar confrontation during class. Again, Ms. Lewis feared this type of reaction, and avoided discussions that had the potential to create discomfort and provoke verbal or physical animosity. Consistent with Ms. Ina's professional development goals, though, she continued to encourage inquiry-based interactions among her students, with the hope of overcoming the negative reaction.

Similar to Ms. Lewis, Ms. Ina set challenging goals for herself during professional development. However, change in Ms. Ina's enactment was at a different pace from Ms. Lewis's instructional change. Here, Ms. Ina struggled to balance tensions of her instructional goals with negative attitudes of the school and community, and the "just do anything attitude" of the students, yet took risks in her enactment. She pushed students to engage in discussions that were unfamiliar to them and she worked to teach in a way that was different for her. Rather than arguing that Ms. Ina's change was better than Ms. Lewis' or that professional development had a greater effect on Ms. Ina's instruction, I argue that Ms. Ina's change also fell on a continuum of instructional change. Even though she also started with inexperience and doubt in the literature, as shown in Chapter 5, she did not have a concrete structure that she was reluctant to compromise. As a result, she seemed more willing to take greater risks during enactment in an attempt to achieve several goals. She pushed students through uncomfortable situations and persevered through negative teacher feedback.

Summary

Professional development has the potential to offer teachers opportunities to be reflective on their practice, and set challenging goals for future instruction. However, when determining whether change in instruction is consistent with professional development, one must consider the conditions of the school and classroom, as well as the teachers' initial ideas about instruction.

Ms. Lewis demonstrated a tension between the theoretical goals of teaching and learning, and the constraints and realities of the classroom, such as institutional and social barriers, like a lack of parental understanding of the process of inquiry. When Ms. Lewis attempted to engage her students in inquiry-based discussions, she seemed to compromise high-risk discussions for the preservation of previously established classroom structure and comfort. She was not willing to make drastic changes to her classroom norms in order to implement new norms from sources that she described as unreliable. Taking into account Ms. Lewis's surrounding conditions, I argue that the level of change that she demonstrated was significant. Although she chose to maintain familiarity in classroom norms and avoid uncomfortable situations, she attempted several of the discussions and strategies suggested in the curriculum and talked about continuing their use, when in the past, she did not do them.

Ms. Ina also demonstrated a tension between theory and practice. Ms. Ina described several constraints that made teaching discouraging, like negative feedback from other teachers, the lack of school support for student achievement, and the familiarity with didactic instruction. She explained that she

believed that the students were capable of engaging in inquiry-based discussions, but described lack of motivation and commitment from the students. However, Ms. Ina did not express fear of compromise; perhaps because she had nothing to lose. During her enactment, she consistently used professional development goals as a standard for instruction, resulting in a change in her instruction. Ms. Ina did not avoid discussions or practices that were uncomfortable, but instead pushed through them.

Professional Development Goals	**Enacted Professional Development Goals**	**Enacted Professional Development Goals**
	Ms. Lewis	*Ms. Ina*
Increasing student ownership of discussions		X
Increasing student engagement during discussions	X	X
Less teacher intervention during discussions		X
Incorporating a public record on the board during discussions	X	X
Increasing appropriate scientific vocabulary during discussions		X
Experimenting with different types of discussions and discussion strategies, such as ascending discussions	X	X
Maintaining structure and comfort when enacting discussions	X	
Increasing individual student ideas		X
Promoting students to challenge the teacher and each other during discussions		X

Table 6-4: Comparing Professional Development Goals with Teacher Enactment

In summary, my analysis of teacher enactment showed that both teachers demonstrated change in instruction that was consistent with their professional

development goals (see Table 6-4). However, those changes occurred at different paces. The rate in which change happened seemed to be dependent on the conditions surrounding the enactment and the teachers' initial ideas about their teaching and students.

CHAPTER 7

DISCUSSION AND IMPLICATIONS

Connecting Professional Development and Classroom Instruction

This study demonstrates that teacher reflection, or analysis, of practice during professional development is an iterative process of enactment and reflection (Dewey, 1938; Fendler, 2003). During professional development, teachers demonstrated a change in how they reflected on their teaching and on their students over time. I assert that these changes were inspired by four key resources: my continued participation with them as a facilitator (Borko, 2004), videos of their own teaching, research articles, and our collaborative conversations. These key resources provided teachers opportunities to situate their learning through video inspired recollection of personal experiences and use extant research in education to support and extend their knowledge and understanding of teaching and instruction. With the key resources, the teachers unpacked specific aspects of their teaching, set instructional goals related to particular challenges, and analyzed the changes required to further develop their teaching of this challenging new unit of study. The teachers attempted to make

changes in their teaching that were consistent with the professional development activities we engaged in and with the goals of the curriculum. With additional resources, such as educative curricula, a shared curriculum, and a small-group setting, analytic teaching practices such as the ones Ms. Ina and Ms. Lewis demonstrated in this study can be developed.

The Importance of Facilitator Participation

Supporting Teachers with Educative Curricula and Promoting Reflection

As facilitator, I situated the teachers' self-analyses and discussions about practice and student engagement in a shared curriculum. Although the curriculum materials included educative features for teachers as they attempted to enact rich, open-ended science discussions, studies have shown that these discussions are difficult for teachers to enact and for students to engage in (Alozie, Moje, & Krajcik, 2009). In many cases, teachers revert to and rely on traditional discussion patterns that are not recommended in learning environments that use inquiry-based methods. As facilitator, I utilized the educative curriculum features as a reference for professional development conversations, which provided the teachers with resources for their classroom context (Putnam & Borko, 2000). My role as the facilitator was to assist the teachers in understanding how the educative features of the curriculum could be realized in the classroom, by not only talking about how they might enact them, but also by making comparisons across teachers, using video to visualize and conceptualize the enactment, by using research articles as exemplars for their

enactment, and by drawing on the collaborative discussions made possible by the small group setting.

My role as facilitator helped move teachers through the iterative process of reflection and enactment in order to address the insufficient reflective practices identified by Fendler (2003), such as: rationalizing personal assumptions about teaching practices and incorrectly calling it “reflection” (Loughran, 2002), the lack of instructional innovation that should come from reflection (Gomez, 1996), and the failure to promote social justice through reflection (Korthagen & Wubbels, 1995). My participation as the facilitator aided in the progression of teacher development during the professional development workshops and speaks to current professional development programs; I deviated from lecture style approaches and built a collaborative and highly involved relationship with the teachers. I worked to make the teachers active members of the learning community by encouraging and supporting them in analyzing their teaching through reflection and experimenting with, and evaluating their ideas through classroom instruction. The teachers’ openness to allow exploration of their teaching methods and ideas of teaching provided conditions in which they were able to reshape the structure of professional development from what is traditionally practiced; they brought the results of their classrooms teaching experiences forward for consideration by the other professional development members.

Building Trusting Relationships Enables Opportunities for Reflection and Enactment Iterations

It is important to note that the changes in reflection teachers demonstrated during professional development were dependent on the establishment and sustenance of trusting relationships between myself and the teachers (Akerson, Cullen, & Hanson, 2009; Grossman, Wineburg, & Woolwoth, 2001; Palincsar, Magnusson, Marano, Ford, & Brown, 1998). In order to establish a professional development learning-environment that welcomes uncertainty, delicate conversations that may lead to changes in instruction, and provide a window into the teachers' classrooms, ideas, and issues, trust must be established. Although teacher critique focused on themselves, rather than on each other, they showed a willingness to admit that they did not know the answers to their instructional challenges and opened themselves to critique and evaluation (although evaluation was not the central goal of the professional development workshops).

The question for professional developers, however, is how to build that kind of trust. As previously discussed, having a shared curriculum in which none of the teachers had extensive experience or expertise may have provided a shared ground and equal footing for the teachers to put forward their concerns. In addition, the facilitator must make an effort to know the teachers and encourage collegiality among the teachers, so that their concerns may be expressed. In this study, I visited classrooms on a regular basis, to help build my relationships with, and understanding of, the teachers. As a result, both teachers had knowledge of my work and position in the study as they continued to participate in the study. In

addition, I worked to establish relationships with the science coordinators of Flint and Detroit. Both coordinators understood the nature of my work, were interested in furthering teacher growth and learning through professional development, and on different occasions, requested professional development workshops. By consistently building relationships with the teachers, understanding their work environments, and meeting the needs of the science coordinators, I was able to establish trust that opened opportunities for in-depth reflection, self-analysis, and instructional change.

Linking Professional Development Resources to Reflective Practices and Instructional Change

Often there are many resources available for improving instruction, however, teachers sometimes do not utilize all of the resources to their best advantage (Cohen, Raudenbush, & Ball, 2003). The development of trusting relationships established during professional development helped link the key resources and provided opportunities for conversations that enabled teachers to utilize the resources as they engaged in enactment-focused reflection. In particular, video cases of their own teaching, as well as reading and discussing research articles, created opportunities for a change in reflection, which appeared to be linked to changes in instructional practice.

My analysis of teacher's use of video makes for interesting comparisons with other studies of video-inspired reflection. Rosaen et al.'s (2008) study on preservice teachers explored how video-inspired reflection compared to written reflection. In their study, they showed that, video-supported reflection helped interns to write more specific (vs. general) comments about their teaching, shift

the content of the reflections from a focus on classroom management to a focus on instruction, and focus less on themselves and more on children. In this study, I found that Ms. Ina's and Ms. Lewis's analytical focus changed from describing what happened, to explaining and interpreting why things happened in the classroom. My analysis demonstrated that, with video, teachers could also dissect their teaching in ways that they could not when teaching in the moment; they were able to look into underlying issues that influenced student learning and made their teaching difficult.

Furthermore, the addition of research articles as a springboard for professional development conversations about video helped enrich teachers' conversation by giving them opportunities to revise their descriptions of instructional problems as students' inability or unwillingness to learn, to consider social and institutional factors that may contribute to the obstruction of student learning, as Korthagen and Wubbels suggested (1995). For instance, after talking about culture as described in the research articles, the teachers related that conversation to video observations. When Ms. Ina observed Ms. Lewis's classroom, she became more curious about how student culture played a role in classroom engagement, and moved away from a deficit perspective on student culture.

In addition, my findings show that, in the context of a small and collaborative group setting, the use of research articles gave teachers opportunities to examine their teaching and look into alternative ideas and strategies. Reading and discussing research articles prompted the teachers to

apply new strategies and ideas in their instructional planning, thinking, and enactment. The teachers acknowledged the difficulty of inquiry-based discussions, and wanted to know how to enact them. Initially, the teachers hoped to use the articles to acquire technical solutions and strategies that would help them enact inquiry-based practices (Zeichner & Tabachnick, 1991). As time progressed, the teachers continued to search for strategies, but in response to my follow-up questions, encouragement, and prompts, the teachers moved away from only searching for technical solutions and also began reflecting on and identifying different reasons for enactment challenges, resulting in instructional changes (Dewey, 1938; Wade, Fauske, & Thompson, 2008).

For example, the articles by Hadjioannou (2007) and Hilton-Brown (2004) started a conversation about understanding student experiences that may originate outside of the classroom, yet contribute to student engagement inside the classroom. By reading and discussing the article with Ms. Lewis and myself, Ms. Ina and Ms. Lewis were able to reconsider their approaches to communicating with their students. After reading and discussing the article, both teachers realized that their students had negative experiences in other classes and in their local communities that contributed to the negative attitudes of the students; Ms. Ina and Ms. Lewis described the students as frazzled, and as showing a poor work ethic. Ms. Ina talked about changing her style of communication with her students, from yelling to talking to them in a calmer and quieter voice. Ms. Lewis talked about bringing them together as a cohesive class before starting instruction. The research articles made the teachers aware of

student experiences, and changed their communication styles in the classroom, which seemed to invite more students to engage in science discussions with less hesitation and resistance.

In addition, the use of research articles enabled teachers to think and talk about broader implications for teaching and research. After reading research articles about student culture (Hilton-Brown, 2004) and inquiry (Keys & Bryan, 2001), Ms. Ina expressed that research on inquiry in urban classrooms did not take into account the experiences of the students. She also said that the generation gap between her and the students made inquiry enactment difficult. She recognized a cultural mismatch among the curriculum, the students, and the teacher (Mensah, 2009). Although her comments about students were not positive, they demonstrated a change in her thinking.

Using a variety of resources helped generate different methods of knowledge construction, thereby enhancing the teachers' experiences during professional development, and increasing their willingness to make instructional changes in the classroom. Specifically, my involvement as facilitator in the group setting, video observation, and research articles opened topics of conversation that may not have been realized otherwise.

Recognizing Progress Promotes Continued Instructional Changes

Through intense and guided professional development conversations, the key resources helped the teachers recognize moments of progress; successful instruction and increased student engagement in light of the expression of apprehension towards research based methods, and institutional and social constraints on teaching and student engagement. This recognition signaled a

turning point in the teachers' perception of themselves and their students. The resources helped the teachers recognize and understand that grounding instructional changes in the curriculum, while taking into account student experiences, could promote student engagement in science discussions. As a result, both teachers talked about persevering with research-based discussion methods.

For instance, Ms. Lewis struggled to balance her doubt of the literature, the lack of support from parents and the school, frazzled students, and a previously established class structure that maintained student and teacher comfort, for new inquiry-based norms that she did not fully trust. As a result, she appeared to omit specific practices, but experimented with new and different pedagogy that did not disrupt her classroom norms.

In Ms. Lewis's case, I worked with her to think and talk about why she omitted particular practices and discussions. Many times, Ms. Lewis spoke of keeping herself and the students comfortable. She expressed a fear of changing familiar classroom interaction patterns for something she did not completely trust. Although she was wary of what research-based methods could teach her, professional development workshops allowed Ms. Lewis to address her issues based on what she read in the research articles, and make comparisons to her own practice. Even though her practice did not show extreme changes, she demonstrated a willingness to persevere when she saw progress in her classroom. She acknowledged that her classroom discussions were not at a

place that could be described as dialogic, but she said that she was working towards such a goal.

Similarly, Ms. Ina worked to balance the negativity she experienced from her school and community, the lack of support from her school, familiarity with didactic instruction, and her doubt of research agendas in urban classrooms, with her goal to increase inquiry-based practices in her teaching. However, Ms. Ina seemed eager to adopt inquiry-based practices in her classroom- a classroom that seemed to lack a structure that she approved of- and took more instructional risks than Ms. Lewis. Ms. Ina applied more ideas from professional development more directly, with the goal of moving closer to inquiry-based discussion practices.

When working with Ms. Ina in the context of the professional development workshops, I pushed her to consider how student experiences outside of the classroom may contribute to their classroom engagement. Ms. Ina often talked about lack of student motivation and work ethic. In order for her to move towards enacting best practices in her classroom, I encouraged Ms. Ina to make three comparisons: between what she experienced and what she read in the research articles, between herself and what she observed in her own video cases, and between herself and Ms. Lewis. Integrating the resources in Ms. Ina's reflection process enabled her to think beyond the tunnel vision of everyday enactment, and focus more her achievements. Ms. Ina developed an understanding of how her approach to teaching contributed to the atmosphere and participation of the classroom. The research articles helped her develop her knowledge of

discussions, and how instruction can be guided by this understanding. Furthermore, tying video to the professional development conversations helped Ms. Ina relate her understanding to her personal practice. As a result, Ms. Ina continued to push herself and her students to achieve the curriculum goals established during professional development.

My analysis of professional development and teacher enactment showed that engaging high school students in rich scientific discussions requires sustained and collaborative professional development for teachers. Connecting research-based knowledge with teachers' expertise and experience can create opportunities for teachers to reflect on their practice in ways that informs their practice (Schon, 1983). This does not mean that there are no standards of teaching (Loughran, 2002); evidence in education research shows that there are teacher practices that can enhance and enrich student learning. Instead, I argue that, when professional development programs situate resources like video cases of teacher enactment and science education research articles in a learning environment that values trusting relationships, collaborative group work, and that has an interactive facilitator, teachers can engage in rich reflective practices that are linked to effective changes in their instructional practices.

I acknowledge that a study of two teachers does not lead to generalizable claims about professional development and classroom instruction. Instead, this study raises important questions that require additional research about professional development with larger numbers of practicing teachers and similar structural features as those presented in this study (Borko, 2004). Research in

science education provides a variety of good teaching practices and professional development can give teachers a forum to discuss, reflect and analyze those practices and how they relate to their classrooms. During instruction, teachers can inform professional development by providing experience-based information, which can inform future enactment, and contribute to research on professional development that is engaging for teachers and relevant to their practices. Although teachers encountered challenges in instruction that led them to resist what they may have perceived as risky teaching practices, such resistance showed the usefulness of the iterative process of reflection and enactment, and the role of a dedicated facilitator. This process encouraged the teachers to continuously revisit their ideas of teaching within the context of their own classrooms.

These findings call for the development of an explicit agenda for supporting teachers to not only manage challenges in the enactment of inquiry-based discussions, but to develop an orientation towards self-reflection, examination, experimentation, and consistent instructional revision. These findings contribute to an ongoing discussion of how professional development designers and facilitators, teachers, and schools can create constructive learning environments for teachers. This study provides empirical evidence for the process of integrating a variety of resources into professional development workshops for practicing teachers.

APPENDICES

Appendix A

Criteria and Indicators

	Criterion	Curriculum Materials	My Practice
1	***Providing a Sense of Purpose:*** To determine whether the attempts to make the discussion purpose(s) explicit and meaningful to students.	How do the teacher supports convey a sense of purpose through discussion that is understandable to students?	How have I made the purpose of the discussion clear to the students?
2	***Taking Account of Student Ideas:*** Taking time to attend to student ideas they already have, both ideas that are incorrect and ideas that can serve as a foundation for subsequent learning.	How do the teacher supports help me in attending to student ideas through discussion?	How did I attend to my students' ideas and responses during the discussion?
3	***Developing and Using Scientific Language:*** To help student make links between scientific language and everyday language and become more comfortable making those connections.	How do the supports assist me in helping student grapple with scientific language?	How did I help students grapple with scientific language?
4	***Demonstrating use of knowledge:*** To help students make their knowledge explicit.	How do the supports demonstrate/model or include suggestions for teachers on how to help students make their knowledge explicit?	How did I help students make their knowledge explicit?
5	***Promoting Students' Thinking about Phenomena, Experiences, and Knowledge:*** To determine whether the curriculum material provides students with opportunities to express, think about, and reshape their ideas.	How do the supports assist me in encouraging students to explain their ideas? What kinds of suggestions do the materials provide me having students express, clarify, justify, and represent his or her ideas?	How do I help students explain their ideas?

Indicators (for curriculum materials and **enactment)**

Criterion 1: *Providing a Sense of Purpose*

1. The materials/teacher conveys or prompts teachers to convey the purpose of the activity to students in a way that is comprehensible to students.
2. The materials/teacher encourages each student to think about the purpose of the activity and how it relates to what they have learned so far.

Criterion 2: *Taking Account of Student Ideas*

1. The materials/teacher does not assume that students have prerequisite ideas or experiences.
2. The material makes adequate connections between ideas in different parts of the unit.
3. The material includes specific questions that could be used by teachers to identify students' ideas, help students make predictions, give explanations of phenomena, and challenge student ideas.
4. The material suggests how teachers can probe beneath students' initial responses to questions or interpret student responses.

Criterion 3: *Developing and Using Scientific Language*

1. The materials/teacher links technical terms to relevant experiences and supports the use of technical terms in order to communicate intelligibly.
2. The materials/teacher helps in the recognition of important aspects of an activity/reading/demonstration that helps in communication. Teachers use an oral rubric, such as key words or correct usage of words to help determine whether the important points are addressed.
3. The materials/teachers provides a sequence of questions or ideas in which the complexity is progressively increased, while providing feedback to students that is gradually decreased.

Criterion 4: *Demonstrating use of knowledge*

1. The materials/teacher expresses the need to use evidence.

Criterion 5: *Promoting Students' Thinking about Phenomena, Experiences, and Knowledge*

1. Materials/teacher encourages all students not only to express but **also** to clarify, justify, and represent their ideas, particularly after an activity or brainstorming discussion.
2. Materials/teacher includes specific suggestions on how to help the teacher provide explicit feedback by diagnosing student errors, explanations about how to correct errors, and recommendations for how students' ideas may be further developed.

Appendix B

List of Readings

**The bolded readings were discussed during the professional development workshops. Others were suggested readings for discussions.

Curriculum Materials and Development

1. Curriculum Materials in Mathematics Education Reform: A Framework for Examining Teachers' Curriculum Development by Janine Remillard
2. Designing Educative Curriculum Materials to Promote Teacher Learning by Davis and Krajcik (2005)
3. Practicing Change: Curriculum Adaptation and Teacher Narrative in the Context of Mathematics Education Reform by Drake and Sherin (2006)
4. **Co-constructing Inquiry-Based Science with Teachers: Essential Research for Lasting Reform by Keys and Bryan (2001)**
5. Supporting Science Teacher Learning: The Role of Educative Curriculum Materials by Schneider and Krajcik (2002)

Discussion Strategies

1. Teacher Questioning in Science Classrooms: Approaches that Stimulate Productive Thinking by Chin (2007)
2. Dialogic Activity Structures for Project-Based Learning Environments by Polman (2004)
3. Guiding Principles for Fostering Productive Disciplinary Engagement: Explaining an Emergent Argument in a Community of Learners Classroom by Engle and Conant (2002)
4. Cultural conflict: Assimilation into the culture of science and its implications for minority students by Bryan-Hilton Brown
5. **What is Classroom Discussion? A Look at teachers' conceptions by Larson and Parker (1996)**
6. **Teacher Views of Discussion by Larson (2000)**
7. Supporting Students' Construction of Scientific Explanations by Fading Scaffolds in Instructional Materials by McNeill et al. (2006)
8. Nassaji, H., & Wells, G. (2000). What's the Use of 'Triadic Dialogue'?: An Investigation of Teacher-Student Interaction. *Applied Linguistics, 21*(3), 376-406.
9. Scott, P. H., Mortimer, E. F., & Aguilar, O. G. (2006). The tension between authoritative and dialogic discourse: A fundamental characteristic of meaning making interactions in high school science lessons. *Science Education, 90*(4), 605-631.

10. van Zee, E., Iwasyk, M., Kurose, A., Simpson, D., & Wild, J. (2001). Student and Teacher Questioning During Conversations About Science. *Journal of Research in Science Teaching, 38*(2), 159-190.
11. Burbules, N. C., & Bruce, B. C. (2001). Theory and Research on Teaching as Dialogue. In V. Richardson (Ed.), *Handbook of Research on Teaching, 4th Edition*. Washington, DC: American Educational Research Association.
12. Wells, G., & Mejia-Arauz, R. (2006). Dialogue in the Classroom *Journal of the Learning Sciences, 15*(3), 379-428.
13. **Hadjioannou, X. (2007). Bringing the Background to the Foreground: What Do Classroom Environments That Support Authentic Discussions Look Like? *American Educational Research Journal, 44*(2), 370-399.**
14. **Brown, B. A. (2004). Discursive Identity: Assimilation into the Culture of Science and Its Implication for Minority Students. *Journal of Research in Science Teaching, 41*(8), 810-834.**

Inquiry

1. Crawford, B. (2000). Embracing the Essence of Inquiry: New Roles for Science Teachers. *Journal of Research in Science Teaching, 37*(9), 916-937.
2. Singer, J., Marx, R. W., Krajcik, J., & Chambers, J. C. (2000). Constructing Extended Inquiry Projects: Curriculum Materials for Science Education Reform. *Educational Psychologist 35*(3), 165-178.

Project-Based Science

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Appendix C

Detailed Coding Example

Open Coding

Interview Excerpt

Ms. Lewis: I think the students are more **comfortable** with them. I mean, a lot of them have been **trained from early** on that here's your information, **learn it and be able to spit it back out**. And **reviewing** just seems that… taking that to the next step. And so, I don't think that it's necessarily the way it turns out, but I think that they might not all know about what we are reviewing, but **they all know something**. So, **they feel more comfortable** throwing out ideas there. And the generating is kind of brainstorming, and **there isn't necessarily a right or wrong answer**, and that also generates a certain level of **comfort**. And so I think the students are just more **comfortable** with it. And from **my own viewpoint**, I think I have just had **more experience** with doing that, both as a student and as a teacher. So, that **increases my comfort** level with those too. Where as the **problem-solving**, from the **standpoint of the teacher**, can be kind of **open ended and that can be scary**, because you are **never quite sure where it's going to go**. And **how do you decide when it's a good place to stop**? And it can be a little bit **more time consuming**. So, those are the reasons why I think generating and reviewing are more common, at least in my classroom.

Professional Development Excerpt 1

Ms. Lewis: I mean getting up to **actually disagree with me makes some of them really uncomfortable**. They are glad to tell me what they think. But I think **they tailor it to what they think I want to hear**. And so I say, "Why do you think that?" or "Tell me more." "Because **that's what you want to hear**."

Professional Development Excerpt 2

Ms. Lewis: A lot of them are **bringing what they have at home and expecting it to be that way**. There is **discomfort**; kids that come in fire and brimstone. **Parents say, "So, he doesn't talk back?"** "No, but we have trouble getting some actual discussions going." "But he doesn't talk back?" But… **I don't' know how to overcome that**.

…..

We have some parent teacher conferences where they are **concerned about behavior**. May standard response is, "If there is behavior trouble, you will hear from me." I had a discussion with a **grandma** that **I would like her granddaughter to disagree with me** and it's not a sign of disrespect. And the **grandmother said, "Well, you're the authority**" and **I don't want the authority, I want to be the teacher**.

Categories	
Teacher Comfort	*Student Comfort*
Reviewing, generating discussions	trained from early on
my own viewpoint	learn it and be able to spit it back out
more experience	reviewing
increases my comfort level	they all know something
problem-solving, standpoint of the teacher, open ended and that can be scary	they feel more comfortable
never quite sure where it's going to go	there isn't necessarily a right or wrong answer
more time consuming	actually disagree with me makes some of them really uncomfortable
I would like her granddaughter to disagree with me	they tailor it to what they think I want to hear.
grandmother said, "Well, you're the authority	that's what you want to hear
I don't want the authority, I want to be the teacher	bringing what they have at home and expecting it to be that way
	discomfort
	Parents say, "So, he doesn't talk back?"
	I don't' know how to overcome that
	parent teacher conferences where they are concerned about behavior
	grandmother said, "Well, you're the authority

Property: How comfort is established (A characteristic of the category that tells location and process)

Dimensions: When did it happen?- Before, during, and after enactment	
Student Comfort: **Subcategory: Where comfort issue is coming from?**	**Subcategory: What comfort looks like in the classroom?**
bringing what they have at home and expecting it to be that way	learn it and be able to spit it back out
trained from early on	they all know something
Parents say, "So, he doesn't talk back?"	discomfort
parent teacher conferences where they are concerned about behavior	there isn't necessarily a right or wrong answer
grandmother said, "Well, you're the authority	actually disagree with me makes some of them really uncomfortable

Axial Coding: Condition: Shows why something happens- Common "why" here was related to what the students brought from home (or some previous experience). In this specific excerpt, it was the home culture that made discussions uncomfortable. The way the students interacted with their parents (authority figures) was the expected behavior in school. Parents did not show explicit support in inquiry-based discussion styles. There is a relationship between timing and how comfort gets established: Before enactment/at home students establish comfort (interactions) with their parents. During enactment/in the classroom students establish comfort (interactions) with the teacher. There is a clash between interactions.

In other excerpts not shown here- student experiences in other spaces also contributed to the difficulty of their participation in inquiry-based discussions.

Selective Coding: Pulls together the codes into a few words that explain what the study is about.

> *Teachers faced the tension between students' home culture (later- "previous experiences") and classroom inquiry goals, often creating an atmosphere of discomfort during enactment.*

Checking for internal logic: Ms. Ina did not necessarily talk about comfort as a tension. She talked about tensions in relation to previous experience. So, I changed "home culture" to "student previous experiences" to encompass both teachers' explanations.

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